CHAPTER 10

IMPACT AND EFFECTIVENESS OF POTENTIAL ALTERNATIVE FUEL MEASURES

10.1 DESIGNING AN ALTERNATIVE TRANSPORTATION FUEL PROGRAM

Chapters 2 and 3 described future energy needs in the state's transportation sector. Even with conservation efforts, transportation energy demand is projected to increase, but as described in Chapter 4, a portion of this demand could be satisfied with alternative fuels. Increased utilization of alternative fuels would further the state's energy goals, such as energy security and benefits to the local economy, while continued reliance on petroleum in the transportation sector would not promote these goals. Chapter 7 described how sufficient resources were available locally to produce a substantial portion of the state's ground sector transportation energy demand, but Chapter 8 showed that locally produced transportation energy would still be substantially more expensive at the pump than fuels derived from imported petroleum.

This Chapter introduces and evaluates measures culled from the possibilities described in Chapter 9 that the state could follow to actively manage energy use in its ground transportation sector.

An evaluation of the benefits of alternative transportation fuels begins with an evaluation of the ability of the alternative fuels to contribute to long-term objectives.

Then, potential measures to increase the use of alternative fuels may be evaluated in terms of facilitating the eventual accomplishment of the long-term objectives. Transition to widespread use of alternative fuels is a gradual process, primarily due to the time necessary to introduce Alternative Fuel Vehicles (AFVs) into the vehicle population.[1] A 20-year horizon appears necessary for petroleum substitution of 20 - 30 percent (see Chapter 4). Therefore, near-term alternative fuel actions are the first steps along a road which will eventually lead to (or not lead to) the accomplishment of long-term objectives.

An alternative transportation fuels program should maximize benefits while minimizing incremental costs. However, benefits and costs are difficult to quantify and have many uncertainties. For example, although in general benefits and costs of oil substitution depend strongly on the degree of substitution, with more substitution bringing more benefits and reduced costs through economies of scale, in some cases the easiest and most cost-effective approaches are found at smaller scales (such as utilizing limited amounts of low-cost feedstocks, or in certain limited niche markets).

[1] 20 years would allow most of the vehicles to be turned over to AFVs. The most attractive and cost-effective vehicles that can use alternative fuels are those supplied as new vehicles by major manufacturers. However, the roll-in of new vehicles is too slow to allow large substitution to be achieved quickly even if vehicle manufacturers made most of the models alcohol-capable. Even the aggressive scenarios in Chapter 4 achieve only about 20 percent substitution by 2014. Such scenarios are unlikely to happen across the country. Rapid substitution would require a national commitment along the lines of the Brazil program, the most rapid substitution strategy ever undertaken. Although Brazil accomplished about 50 percent substitution in a decade, Brazil strongly directed the types of cars to be built (since car production was largely domestic) and also supported an aggressive vehicle retrofit program. There is no U.S. consensus that such a rapid substitution is needed. It would probably also be unwise, given the expected improvements in alternative fuels technologies.

Further complications include the following:

1. Costs of alternative fuels change with time.

Costs are expected to fall as alternative fuel production technology improves.

2. Future prices of oil cannot be accurately projected.

Future petroleum prices are uncertain, involving both short-term volatilities and long-term price changes. Scenario-based projections of petroleum prices show wide variations between low and high cases. This makes assessments of the net value of substitution programs difficult. Note also that projections are for the market price of oil and do not account for possible additional externality[2] costs which may be included in the future.

3. Net cost/benefit assessments must cover many years.

Relative costs of petroleum and alternative fuels will change with the amount of displacement and time. Many of the costs of a substitution program come early when volumes of alternative fuel and numbers of AFVs are low, and economies of scale have not yet been achieved. On the other hand, the benefits of avoiding the externalities of oil only occur after a substantial amount of petroleum substitution has been attained. Hence, costs and benefits have to be compared over many years, or in some "discounted" or "net present amount" sense.

4. Because low-cost AFVs are key to the cost-effectiveness of substitution, and Hawaii is neither a major manufacturer[3] nor consumer of vehicles, Hawaii's optimal fuel mix may be determined by decisions made outside of Hawaii.

Since Hawaii is a small market compared with the output of major vehicle manufacturers, and since costs are reduced and consumer appeal increased with factory produced AFVs (as compared to retrofits and conversions), Hawaii's "optimal" mix may be affected by decisions outside of Hawaii as large vehicle manufacturers cope with mainland Energy Policy Act (EPACT) goals and air quality programs.

5. While a substitution program must make reasonable first guesses of goals and policies, it must also be flexible.

Because uncertainties are great and least-cost approaches are difficult to define with certainty, the optimal mix (based on present information) should incorporate as much flexibility as possible. Dual-fuel, bi-fuel, and fuel-flexible vehicles[4] are more flexible than vehicles dedicated to one fuel, and fuels with uses other than transportation are better than those limited to transportation.

[2] "Externality costs" are those costs which are attributable to the use of a product but which are paid for in such a way that the "cost" is not included in the price of the product. Examples are the costs of pollution and the costs of defending oil supplies.

[3] Although Hawaii is beginning to produce EVs and has produced converted propane vehicles, it cannot be considered a major supplier of AFVs.

[4] Dual-fuel vehicles are those which run on a combination of alternative and conventional fuels at the same time; bi-fuel vehicles are those which can run on either an alternative or conventional fuel, using only one fuel at a time; and flexible-fuel vehicles (FFVs) are those which run on variable blends of alcohol and gasoline.

Because of the factors above, it is difficult to quantify the desired amount of substitution and the "optimal" mix of alternative fuels. The important issues are the following, and they lend themselves to a semi-quantitative analysis:

1. Should Hawaii be promoting energy diversification in the transportation sector now? Is immediate substitution worthwhile?

2. Can near-term substitution objectives be related to long-term objectives? (As an example, if electric vehicle technologies are projected to improve greatly over the next 20 years, how hard should a near-term alcohol program, which could be implemented right away, be pushed?)

3. What is the long-term energy substitution objective for Hawaii's transportation sector? How should this objective be determined if costs and benefits are uncertain? In addition to the state's energy policy goals (see Chapter 5), how important should local economic benefits be in setting the substitution goal?

4. How do the long- and near-term substitution objectives relate to the screening criteria (Chapter 5)? The screening criteria compare the alternative fuels among themselves, but how do the alternatives compare to petroleum fuels?

5. Do some substitution levels have adverse impacts on local refineries, such as unbalancing their product slate? To what extent should substitution goals be affected by refinery impacts?

6. For any given displacement objective and time frame, should specific alternative fuels gain market share, and what are the optimum proportions of alternative fuels if several are worth having?

7. What are the uncertainties and contingencies, and how much program flexibility is appropriate?

The following sections address these questions.

10.2 CONTRIBUTION OF ALTERNATIVE TRANSPORTATION FUELS TO LONG-TERM OBJECTIVES

10.2.1 ENERGY SECURITY ISSUES

"Energy security" has several components (State of Hawaii, Department of Business, Economic Development & Tourism, 1993):

- "supply security" (physical availability of fuel);
- "price security" (stability of price); and
- "economic security" (protection from the consequences of energy price fluctuations elsewhere, which could involve access to non-petroleum energy supplies).

The use of alternative fuels can address all of these components of energy security, but little energy security benefit can be realized unless the petroleum substitution is large enough for the economy to function in the event of a disruption.[5] Whether this means that Hawaii should substitute 30, 50 or 70 percent of the petroleum used in its ground transportation sector is difficult to say, but to consider energy security to be achieved, the amount of substitution should be much larger than a few percent.

Note however that substitution is not desirable unless it provides benefits greater than the incremental costs of continuing to depend on oil. At today's petroleum costs, it is debated whether any substitution is worthwhile based on externality costs alone (California Energy Commission, 1994). Some analysts have concluded that oil provides more benefits at less cost than the alternative fuels, even when oil externalities and the economic benefits of local production of alternative fuels and AFVs are included; however, each region's costs and benefits are different and assessments must be made on a case-by-case basis.

The situation may be considerably different in the future. As oil reserves dwindle, substitutes for petroleum will become necessary. As that time approaches, the consideration of externalities associated with continued gasoline and diesel use becomes more important. For example, while gasoline and diesel could be produced from coal, the environmental effects of using coal as a gasoline and diesel feedstock on the scale required to replace petroleum reserves would be tremendous. At the same time, the costs of alternative fuels are expected to decrease in the future, especially if near- and mid-term programs encourage development of alternative fuel technologies.

[5] Small amounts of substitution may have benefits that, though small, are desirable. For example, users of alternative fuels, even if small in number, are relatively insulated; conversion of wastes to a valuable resource is helpful; and it would be worthwhile to stimulate the local manufacture of AFVs.

Therefore, the long-term substitution goal may remain broad and generally correspond to the most aggressive scenarios of Chapter 4, i.e., 20-30 percent substitution by 2014. Since it would not be possible in any case to obtain large substitution very rapidly, adjustments in long-term goals would have little influence on near-term decisions and programs as long as long-term objectives are relatively large and distant. In other words, long-term goals could be regularly reevaluated and refined without affecting the near and mid-term program, as long as near-term alternative fuel actions lead in the general direction of long-term objectives.

All of these factors were considered extensively during the development of U.S. energy policy. The debates became particularly intense during the discussions of EPACT. In the end, although nominal goals of 10 and 30 percent nationwide substitution were established for 2000 and 2010, respectively, EPACT's implementation measures (fleet purchase requirements) only provide a nationwide substitution of 4 percent by 2010. The gap between the nominal goals and the substitution achieved by fleet requirements is supposed to be made up by voluntary measures, many of them at the state and local level, and the Secretary of Energy is to report to Congress periodically on the progress of the substitution effort. Many feel that the modest extent of the mandatory measures included in EPACT is deliberate, intended to provide time for alternative fuel technologies to develop and costs to be reduced. Hawaii could similarly follow the EPACT approach and distinguish long-term goals from short-term programs.

10.2.2 ENVIRONMENTAL ISSUES

Alternative fuels have several characteristics which make them environmentally attractive. First, they are generally cleaner burning, and thus contribute less to smog formation in urban areas. Second, fuels made from renewable sources (such as trees, grasses, and even waste products) add less net carbon dioxide to the atmosphere and therefore contribute less to global warming. And third, accidental leaks or spills of alternative fuels are potentially less damaging to marine environments than petroleum or petroleum product spills.

10.2.2.1 AIR QUALITY

In areas of the U.S. with air quality problems attributable to mobile source emissions, "clean fuels" and "clean vehicles" are important elements in air quality improvement programs. In 1990, sixty-one percent of carbon monoxide (CO), thirty percent of nitrogen oxides (NOx), and twenty-four percent of volatile organic compounds air pollutants in the U.S. came from burning gasoline and diesel fuels in cars and trucks (U.S. Environmental Protection Agency (USEPA), 1992).

Carbon Monoxide

Exposure to carbon monoxide, a colorless and odorless gas, can cause headaches and place additional stress on persons with heart disease (Gordon, 1991). In higher doses, it binds to red blood cells and can cause carbon monoxide poisoning or asphyxiation.

"Based on monitoring data from the State Department of Health, present air quality...is relatively good, although air quality modeling results indicate the presence of some carbon monoxide "hot spots" near traffic congested intersections" (R.M. Towill, 1991).

Ozone

Ozone, while beneficial to the Earth in the upper atmosphere, is called "smog" at ground level and can cause shortness of breath and lung damage. It is formed by the reaction of NOx and hydrocarbons in the presence of sunlight.

"EPA's own clinical laboratories found that otherwise healthy, exercising individuals show significant effects after six hours of breathing ozone at levels below the threshold of the current health standard...the long-term effect of repeated exposures to such levels is one of the many questions remaining in the area of health-effects research" (Garrison, 1991).

Emissions from Alternative Fuels

Figure 10-1 shows data from the CleanFleet program.[6] Although several manufacturers' vehicles were involved in the CleanFleet program, only one manufacturer had vehicles operating on all four fuels (compressed natural gas (CNG), a blend of 85% methanol and 15% gasoline (M85), liquefied petroleum gas (LPG/propane), and gasoline); that data is shown below.

All of the alternative fuel vehicles produced less carbon monoxide than the control gasoline vehicles. Although some alternative fuels produced more NOx and hydrocarbons than gasoline, it is the reaction between NOx and hydrocarbons (some hydrocarbons are less reactive than others) that produces ozone. The alternative fueled vehicles produced fewer ozone-causing emissions overall than the control gasoline vehicles.

Tailpipe emissions from electric vehicles are zero, since no combustion is occurring on-board the vehicles. When emissions from power plants are considered, carbon monoxide emissions are close to zero and emissions of NOx, which depend on the particular power plants producing electricity at the time the electric vehicles are charged, are also much less than for gasoline vehicles. With Hawaii's statewide average mix of power production, CO and NOx emissions per mile would be similar to the electric vehicle (EV) emissions shown in Table 10-1.

Other Air Toxic Emissions

In addition to carbon monoxide and ozone, there are several other toxic air-borne chemicals (referred to as "air toxics") associated with vehicle fuels. Benzene, toluene, polycyclic organics, and formaldehyde are a few. Benzene, a known potent cancer-causing substance, is present in all Hawaii gasolines. Eighty-five percent of human exposure to benzene comes from gasoline (Durenberger, 1991).

There is increasing concern over the health effects of long-term low level exposure to air toxics; the Clean Air Act Amendments of 1990 name 189 toxic air pollutants, typically carcinogens, mutagens (substances which can cause gene mutation), or reproductive toxins. "For the most part, these chemicals and their potential effects on human health have been known for some time. 'Protect the public health with an ample margin of safety' was particularly controversial in the case of carcinogens, because they pose some risk at even very low emission levels" (Wegman, 1991).

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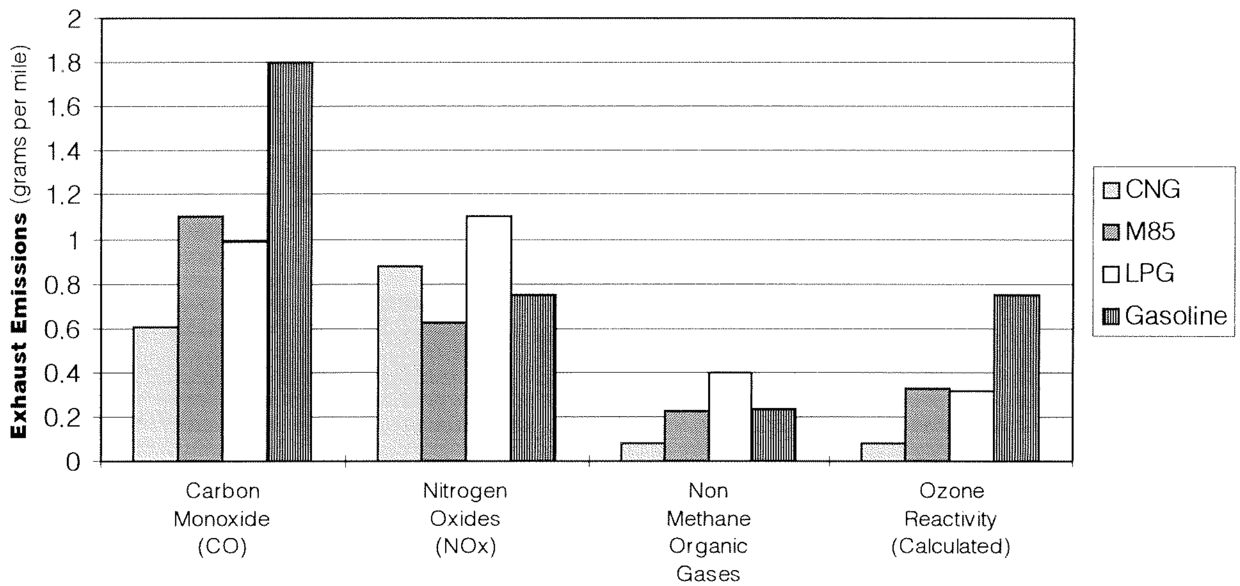
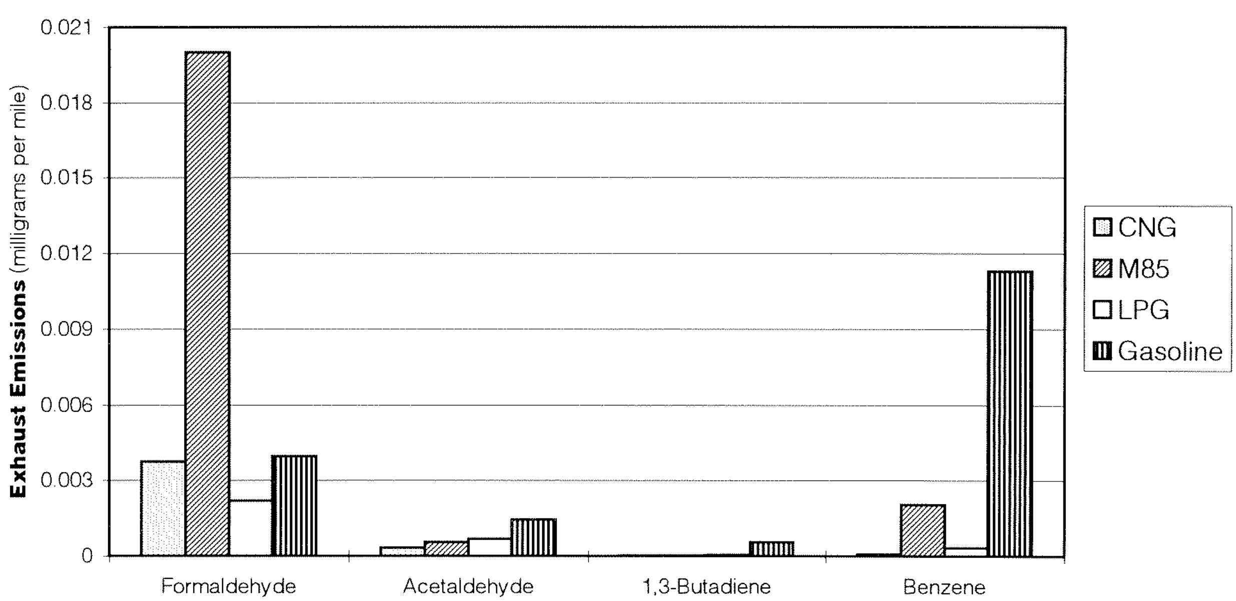
[6] The CleanFleet program, sponsored by USDOE, USEPA, the South Coast Air Quality Management District, the California Energy Commission and private companies, with technical services by Battelle, was a demonstration of panel vans in commercial operation using liquid and gaseous fuel technologies which were available for commercial service in 1992.

Figure 10-1.
Alternative Fuel Vehicle Emissions



Alternative fuel vehicle emissions are different from gasoline, particularly with respect to formaldehyde and acetaldehyde. CleanFleet Program data on toxic emissions was used to generate Figure 10-2.

Figure 10-2.
Air Toxic Emissions from Gasoline and Alternative Fuel Vehicles



The graph above shows total amounts of emissions. However, risk and toxicity are not based on emission mass alone. Benzene, a "Group A" (known human carcinogen) substance, is worse than formaldehyde, acetaldehyde, or 1,3-Butadiene, which are classified as Group B1 and B2 (probable human carcinogens) (USEPA, 1993). Also, each of the toxics have different atmospheric residence times and transformation properties. Weighting factors[7] (based on carcinogenicity and atmospheric residence times) were applied to the above emissions levels to obtain the relative rankings of emissions shown in Figure 10-3.

The emissions data presented up to this point has focused on existing technology. Dedicated alcohol-fueled vehicles, however, would offer even greater emissions benefits than the flexible-fueled vehicles, since they would be optimized to increase fuel economy as well as combustion efficiency; catalysts could also be optimized to remove formaldehyde and acetaldehyde. Estimates of relative emissions from additional types of vehicles are presented in Table 10-1.

10.2.2.2 GREENHOUSE GAS EMISSIONS

Fossil fuels are major contributors to the increasing levels of atmospheric carbon dioxide implicated in global warming. As the situation is described by experts,

> "The amount of carbon dioxide in the atmosphere has been increasing by 0.4 percent a year because of the use of fossil fuels such as oil, gas, and coal ... The net effect of these increases could be a worldwide rise in temperature, estimated at 2° to 6° C (4° to 11° F) over the next 100 years. Warming of this magnitude would alter climates throughout the world, affect crop production, and cause sea levels to rise significantly. If this happened, millions of people would be adversely affected by major flooding." (Microsoft Encarta, 1994)

> "An even more fundamental limit *[than supply limitations]* on fossil fuel use is the atmosphere's ability to cope with the burden of nearly six million tons of carbon emissions each year. Scientists predict that these emissions will warm the atmosphere at an unprecedented rate, and may eventually undermine the economy itself. Combustion of all the world's remaining fossil fuels would raise the concentration of carbon dioxide as much as tenfold, compared with the mere doubling that now concerns scientists. Slowing global warming inevitably means placing limits on fossil fuel combustion." (Flavin, 1990)

Fuels from non-fossil fuel sources include fuels made from biomass or generated from solar, wind, and hydropower (for example, abundant hydropower in Canada has been used to produce low-cost hydrogen for use as a fuel). Electricity from a renewable source (e.g. solar, wind, etc.) is also considered a "renewable fuel." Figure 10-4 illustrates the use and production of carbon dioxide (CO_2) from non-renewable versus renewable sources.

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[7] Wang, 1993. Weighting factors used: Benzene, 10; 1,3-butadiene, 9.37; formaldehyde, 1.31; and acetaldehyde, 0.31.

Figure 10-3.
Weighted Air Toxic Emissions from Gasoline and Alternative Fuel Vehicles

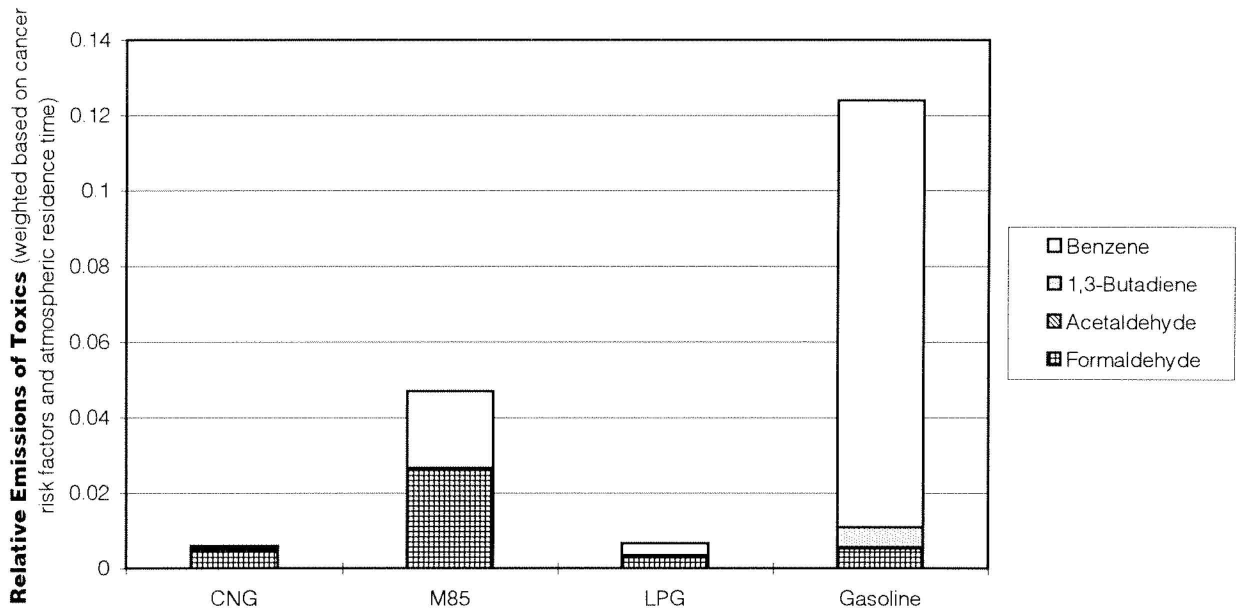
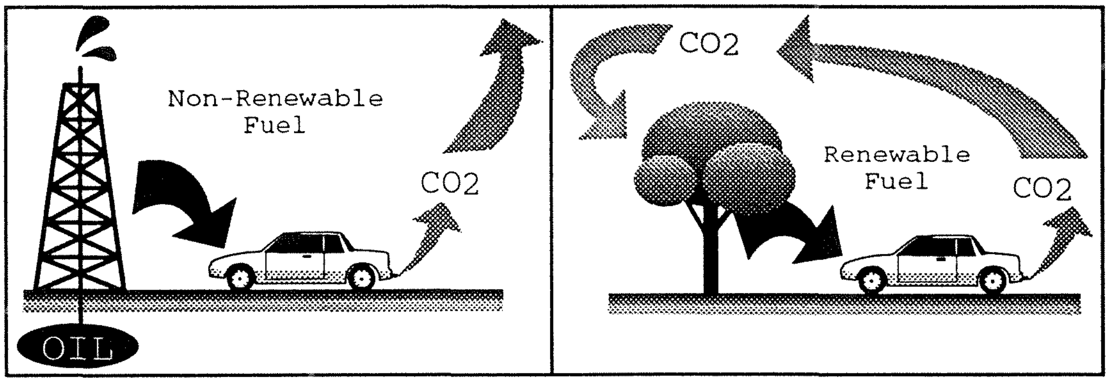


Table 10-1
Alternative Fuel Vehicle Emissions Rates Relative to Gasoline Vehicle Emissions

Vehicle Type	Exhaust Emissions						
	CO	**NOx**	**NMOG**	**Benzene**	**1,3-Butadiene**	**Acetaldehyde**	**Formaldehyde**
Gasoline Vehicle, Tier I	100%	100%	100%	100%	100%	100%	100%
M85 FFV	90%	90%	45%	15%	20%	25%	380%
M100 FFV	90%	90%	40%	84%	20%	25%	345%
M85 Dedicated	85%	90%	35%	10%	15%	20%	295%
M100 Dedicated	80%	90%	30%	10%	15%	20%	260%
E85 FFV	90%	90%	70%	10%	20%	925%	140%
E85 Dedicated	85%	90%	65%	5%	15%	760%	128%
LPG Dual-Fuel	70%	100%	30%	5%	5%	50%	115%
CNG Dual-Fuel	70%	100%	10%	1%	5%	35%	170%
CNG Dedicated	60%	90%	10%	1%	5%	30%	140%
EVs	5%	40%	5%	0%	0%	0%	5%

Source: Wang, 1993. E85 dedicated vehicle rates added.

Figure 10-4.
Carbon Cycle for Renewable vs. Non-Renewable Fuels



As illustrated above, the carbon cycle for non-renewable fuels, such as gasoline and diesel fuel from petroleum, involves pumping the fuel out of the ground, processing it into and using it as a fuel, and releasing the products of combustion (including CO_2) into the atmosphere without any subsequent recovery of the CO_2 (thus the increasing accumulation of CO_2 in the atmosphere). The renewable fuel, such as fuel from biomass, also results in the release of CO_2 when the fuel is burned - but in this case, the biomass re-uses the CO_2 as part of its growing cycle.

Actual fuel and carbon cycles are more complex than the simplified diagram above indicates; the processing of materials into fuels, and the growing of energy crops, involve energy inputs of their own, as do transporting of the fuels and even manufacture of the vehicles. Life cycle emissions of greenhouse gases are difficult to quantify; however, alternative fuels in general contribute less net CO_2 to the atmosphere than does gasoline (USDOE, 1994).

10.2.3 LOCAL ECONOMIC BENEFITS

Having examined the long-term goals of energy security and environment, it is instructive to examine the long-term goal of local economic benefits.

There is a general belief that domestic production of alternative fuels, although perhaps more expensive than oil, would provide economic benefits such as new domestic investment and local jobs. This theme underlies the financial incentives in EPACT and recent discussions on domestic production of components of reformulated gasoline.

In Hawaii, economic benefits may be even more significant given the condition of the state's sugar industry. Hawaii's sugar industry declined from 7,282 direct hourly employees in 1980 to 4,453 in 1990, a loss of more than 2,800 direct jobs and approximately 10,000 total jobs given a multiplier of 3.54 associated with this industry (State of Hawaii, Department of Agriculture, 1994). Could alcohol fuels and local production and conversion of EVs stimulate investment and job creation in Hawaii? Would the cost of an alternative fuel program be less than the cost of the economic adjustment required with the continued decline of Hawaii sugar?

Worldwide, the investment required to create jobs ranges from $30,000 to $100,000 (Geller, 1985). If an alternative fuel program in Hawaii could be designed to preserve jobs at costs in this range, such a program may be considered to be competitive with typical options for job creation.

10.2.3.1 ALCOHOL FUELS

As shown in Chapter 8, different options for alcohol importation and production result in different cost projections; generally speaking, higher costs are projected for smaller scales of alcohol demand and the lowest costs are projected for the highest levels of demand. In this study, alcohol importation/production scales were separated into phases as shown in Table 10-2.

Table 10-2.
Phases of Alcohol Demand

ALCOHOL	GEG ALCOHOL FUELS		ALCOHOL DEMAND (gallons of 100% alcohol if all alcohol fuel is methanol)	
PHASE	FROM	TO	FROM	TO (approx.)
1	0	674,716	0	1,000,000
2	674,716	10,120,743	1,000,000	15,000,000
3	10,120,743	30,362,229	15,000,000	45,000,000
4	30,362,229	60,724,458	45,000,000	90,000,000
5	60,724,458	400,000,000	90,000,000	592,841,848

The lowest-cost option (based on mid-range of cost projections) in each phase determines the subsidy amount necessary for alcohol fuels to meet the current price of gasoline on an energy equivalent (GEG) basis in each phase. Results (assuming that fuel taxes have already been adjusted on the basis of energy content) are shown in Table 10-3. Subsidies would only be provided to importers of alcohol fuels in the early phases of the program, and discontinued once adequate quantities of alcohol fuels were being produced in-state.

Consider a large-scale alcohol industry corresponding to substantial petroleum substitution. It could include a 59 million gallon per year (mgpy) fiber-to-methanol plant large enough to attain economies of scale. An alternative fuels program focused on making the methanol produced at this plant competitive for use in M85 vehicles (as compared to gasoline at the pump) would require a subsidy ranging from seven cents per gallon ("low cost" case) to about 42 cents per gallon (average of "low cost" and "high cost" cases) (see Table 10-4).

Table 10-3.
Estimated Alcohol Subsidies for M85 and E85 Fuels to be Competitively Priced in Hawaii

Acohol Fuel Subsidy	**Alcohol Phase 1: 0 to 0.67 million GEG**	**Alcohol Phase 2: 0.67 to 10 million GEG**	**Alcohol Phase 3: 10 to 30 million GEG**	**Alcohol Phase 4: 30 to 61 million GEG**	**Alcohol Phase 5: 61 to 400 million GEG**
for M85/E85 fuels	$/GEG (1)	$/GEG	$/GEG	$/GEG	$/GEG
For fuels not produced in Hawaii	$1.38	$0.90	N/A	N/A	N/A
For fuels produced in Hawaii	N/A	$0.90	$0.73	$0.63	$0.47

1. $/GEG refers to $ per gasoline equivalent gallon. One gasoline equivalent gallon = 1.4 gallons of E85 and 1.74 gallons of M85.

Table 10-4.
Projected Cost of Methanol for Use as M85

Methanol Scenarios	Methanol Annual Volumes (gallons 100% alcohol)	Sold as M85				
		With GEG-adjusted Taxes (2)		With Alcohol Fuel Subsidy		
		Low Pump Price ($/GEG) (1)	High Pump Price ($/GEG)	Low Pump Price ($/GEG)	High Pump Price ($/GEG)	Average of Low & High ($/GEG)
M1a. Methanol Imported	6,000	$2.59	$3.22	$1.21	$1.84	**$1.52**
- Containers	170,000	$2.60	$3.23	$1.22	$1.85	$1.54
M1b. Methanol Imported	714,000	$3.34	$4.14	$1.96	$2.77	$2.36
- Parcel Tanker	1,275,000	$2.66	$3.17	$1.28	$1.80	$1.54
	>60,000,000	$1.82	$1.99	$1.82	$1.99	$1.90
M2a. Methanol Made	10,000,000	$1.96	$3.21	$1.05	$2.31	$1.68
from Banagrass				$1.23	$2.49	$1.86
on Oahu	59,000,000	$1.59	$2.72	$0.87	$1.99	$1.43
				$0.96	$2.09	**$1.52**
	184,000,000	$1.52	$2.62	$1.05	$2.15	$1.60
				$1.05	$2.15	$1.60
M2b. Methanol Made from Coal	1,247,000,000	$2.62	$2.62	$2.15	$2.15	$2.15
with electricity co-production	1,247,000,000	$2.00	$2.00	$1.52	$1.52	**$1.52**
M3. Methanol Made	10,000,000	$2.45	$3.80	$1.54	$2.89	$2.22
from Banagrass				$1.72	$3.07	$2.40
on a Neighbor Island	67,000,000	$1.86	$2.99	$1.23	$2.36	$1.80
and Shipped to Oahu				$1.38	$2.52	$1.95
	375,000,000	$1.75	$2.85	$1.28	$2.37	$1.83
				$1.28	$2.37	$1.83

Notes:
1. $/GEG refers to $ per gasoline equivalent gallon. One gasoline equivalent gallon = 1.4 gallons of E85, 1.74 gallons of M85, and 1.03 gallons of E10.
2. Since alternative fuels contain less energy per gallon, more gallons are used to travel the same distance. GEG-adjusted taxes take this into account.
3. Per gallon 100% alcohol produced.

Is such a subsidy cost-effective for job preservation? Investment in one of these plants could, circumstances permitting, preserve 2,000 - 2,500 direct and indirect jobs (derived from the yield-per-acre and employment-per-acre data summarized in Tables 10-5 and 10-6). The jobs associated with such a plant, which would supply about 7 percent of the fuel demand for ground transportation in Hawaii, could offset some of the job loss experienced by the Hawaii sugar industry from 1980 to 1990.

If the fuel was subsidized at the rate of 7 cents per gallon, the cost of the fuel subsidy in that year (assuming all factors, including gasoline prices, remain constant) would be $4,000,000 or about $2,000 per job. If the fuel was subsidized at the rate of 42 cents per gallon, the cost of the fuel subsidy would be $25,000,000 or about $11,000 per job. Whether these would be reasonable or desirable levels of public support depends on the total value to the state of this economic activity and whether these levels of support could be reduced or eliminated as feedstock prices decreased, technology improved, or other conditions changed.

The actual cost of achieving such levels of demand will include elements such as vehicle purchase incentives and/or additional vehicle costs; higher subsidy levels and/or costs in earlier program phases; and research, development, and demonstration program costs.

Table 10-5.
Acreage and Yield for Alcohol Production

Gallons / ton dry matter:					
Methanol from Fiber		Ethanol from Sucrose (1)		Ethanol from Fiber (1)	
150		154		83	
Fiber crop yield (dry tons/acre-year):					
	230,000 acres high-yield land		100,000 acres medium-yield land		
Banagrass	22		18		
Trees	12		10		
Sugarcane crop yield (dry tons/acre-year), high yield land:					
Sugar		Fiber		Both	
6.52		12.57		19.09	
Gallons Alcohol per Acre-Year:					
Banagrass - high-yield land		Banagrass - medium-yield land		Ethanol from Sucrose	Ethanol from Sucrose + Fiber
Methanol	Ethanol	Methanol	Ethanol		
3300	1826	2700	1494	1004	2047
Annual Alcohol Use (2)		**Total Acres Required to Support Demand**			
Methanol demand (mgpy)	Ethanol demand (mgpy)	Methanol-low (Banagrass, high-yield land)	Methanol-high (Banagrass, med-yield land)	Ethanol-low (Sugarcane crop)	Ethanol-high (Banagrass, med-yield land)
5	4	1,515	1,852	1,825	2,501
10	7	3,030	3,704	3,651	5,002
25	19	7,576	9,259	9,127	12,506
50	37	15,152	18,519	18,255	25,012
59	44	17,879	21,852	21,540	29,515
100	75	30,303	37,037	36,509	50,025
125	93	37,879	46,296	45,637	62,531
150	112	45,455	55,556	54,764	75,037
184	138	55,758	68,148	67,177	92,045
300	224	90,909	111,111	109,528	150,074
500	374	151,515	185,185	182,546	250,123

1. Assumes the following conversion efficiencies: sucrose to ethanol, 0.96; cellulose to ethanol, 0.95; hemicellulose to ethanol, 0.42.
2. Gallons of M100 or E100.

As described previously, there are numerous factors affecting the potential demand for alcohol fuels (chief among which is the availability of alcohol-fueled vehicles). As circumstances change, and as more specific program direction and program goals are developed, the tools developed in this project may be used to update and refine the estimates of job creation, total program cost, and cost-effectiveness.

Table 10-6.
Employment Implications of an Alcohol Production Industry in Hawaii

Annual Alcohol Use (1)		Displacement	% of Annual	**Direct+Indirect Labor** (Full-Time Workers) (2, 3)			
Methanol demand (mgpy)	**Ethanol demand** (mgpy)	of gasoline and diesel (million GEG)	Ground Sector Demand	**Methanol** Low	High	**Ethanol** Low	High
5	4	2	0.7%	177	217	214	293
10	7	5	1.3%	354	433	427	585
25	19	12	3.3%	886	1,083	1,068	1,463
50	37	25	6.5%	1,772	2,166	2,135	2,925
59	44	29	7.7%	2,091	2,556	2,519	3,452
100	75	50	13.1%	3,544	4,332	4,270	5,851
125	93	62	16.3%	4,430	5,415	5,338	7,314
150	112	75	19.6%	5,316	6,498	6,405	8,776
184	138	92	24.1%	6,521	7,971	7,857	10,766
300	224	149	39.2%	10,633	12,995	12,810	17,553
500	374	249	65.4%	17,721	21,659	21,350	29,254

1. Gallons of M100 or E100
2. To arrive at high/low range of employment, use high and low gallon per acre scenarios. Tree crop scenarios excluded because yields are lower and costs higher for trees, compared with banagrass, rendering tree crops generally less attractive on a statewide basis.
3. Assumes 5650 direct employees and 20000 direct plus indirect jobs per 171000 acres.

10.2.3.2 ELECTRIC VEHICLES

EVs may provide attractive economic opportunities as well. EVs are already being produced in Hawaii, and local production will increase through the Hawaiian Electric Vehicle Demonstration Project (HEVDP). A study identified more than 24,000 direct and indirect jobs in California if EVs were manufactured there to meet the 10 percent zero emission vehicle (ZEV) requirement. Thus, scaling on the relative number of automobiles in California and Hawaii, if EVs could obtain a 10 percent market share in Hawaii, there could be about 1,000 direct and indirect jobs associated with EV production in Hawaii. Although the actual number could be less if Hawaii did not produce all the components, EV production could still create a significant number of jobs in Hawaii.

10.2.4 REFINERY IMPACTS OF SUBSTITUTION

The Hawaii Energy Strategy Project 2, *Fossil Energy Review* (1993) considered the impacts of alternative fuels substitution on the two oil refineries in Hawaii and concluded that even the most aggressive scenario considered in Chapter 4 does not cause seriously negative impacts on the refineries, provided refinery investments are appropriately made. With sufficient government and private sector cooperation, refinery impacts do not preclude an aggressive substitution goal.

10.2.5 SUMMARY

A long-term goal of petroleum displacement of 20-30 percent in the ground transportation sector supports long-term objectives of energy security, environmental protection, and local economic development.

10.3 POTENTIAL ELEMENTS OF AN ALTERNATIVE FUELS PROGRAM

10.3.1 PROGRAM CONSTRAINTS

The following policy questions need resolution at the outset. The discussion below suggests certain policy decisions that have been assumed as the starting point for the program.

1. Should the Hawaii substitution program be "fuel neutral"?

The program should encourage those fuels that provide the most energy security and economic stimulus benefits to Hawaii; the level of support should be directly related to the extent of the benefits and potential benefits which could be provided to Hawaii by the use and production of the fuels. From this perspective, therefore, the program should be "fuel neutral" in the sense that any fuel providing the equivalent amount of benefits and potential benefits as any other fuel should receive the same level of encouragement. The fuels are only a means of meeting the objectives.

Since it appears that electric and alcohol fuels provide the most benefits and potential benefits to Hawaii at this point, they merit the most support; biodiesel, if shown to be feasible at large scale, could also merit a comparable level of support. Propane, although it does not merit financial support, does fulfill a role in helping to meet certain fleet requirements and therefore merits support in terms of publicity and information dissemination.

2. Should indigenous sources be preferred over imports?

Yes, although "secure" imports may have some value. Enhancing the "security" of imports has not been evaluated in this project.

3. Should program funding stay within the transportation sector, or should other economic sectors be included?

It would be preferable to keep the program within the transportation sector, if possible, since the transportation sector is the one whose security is a primary motivation of the program. Consequently, subsidies and other support for alternative fuels should be obtained from users of gasoline, diesel fuel and owners and operators of conventionally fueled vehicles in a "revenue neutral" manner. This is in contrast to "externality fees" which are designed to raise the price of oil to cover its external costs (see Item 4 below).

However, the measures discussed later would result in some revenues from gasoline, diesel, and conventional vehicle taxes and fees flowing to the agricultural sector to encourage alcohol production. Since overall statewide economic benefits are a major goal of the program, and because of the overall benefits of energy diversification, this shunting of funds seems appropriate. Nonetheless, this is a decision that the state must confirm.

4. Should gasoline and diesel fuel carry fees or taxes large enough to "internalize the externalizes," thereby placing the alternative fuels on a "level playing field" with conventional fuels?

The pricing of petroleum does not include all of its "externalities" in its cost basis. Examples of petroleum externalities include defending foreign oil supplies, cleaning up oil spills, and air pollution resulting from petroleum fuels. The externalities of petroleum are legitimate costs, but to date they have been paid by others or not yet paid. Externality fees would perhaps be $1 or more per gallon.[8]

Incorporating externality costs in the price of petroleum fuels is often advocated by theoreticians because it would strengthen "market based" approaches to fuel diversification without further government involvement. If non-petroleum alternatives were cheaper, they would gain a market share. However, full externality pricing of petroleum is not viewed as practical because this level of fees is unlikely, especially at a state level where state businesses facing such fees would be at a substantial competitive disadvantage in comparison with businesses in other states without such fees. Furthermore, the rapid introduction of such a high tax on fuel would probably cause economic disruption and depressed business activity. Also, if the additional revenues were diverted to an alternative fuel program, such pricing would generate more funds than necessary. In sum, although externality fees might have benefits, there would also be severe adverse effects. Therefore, "leveling the playing field" through "externality fees" on gasoline and diesel fuel is not included in the proposed measures.

However, this conclusion does not eliminate the consideration of new taxes on conventional vehicles and petroleum fuels. The fees and taxes would be small compared with the total externality costs, and would serve as revenue generators for the alternative fuels program.

5. How should the level of subsidy be determined?

Subsidies are needed in the near term to begin introduction of alternative fuels. Alternative fuel subsidies[9] can equal the amount needed to achieve price parity or the amount justifiable given the expected benefits of the alternative fuel. Acceptable costs for measures are costs which do not exceed quantifiable program benefits.

[8] California has recently surveyed the state of knowledge of externality costs for petroleum as part of a statutory required assessment and report. Costs of defending oil and weathering recessions triggered by instability in oil prices appear to be about $20 per barrel. Environmental damage would add some additional costs. Therefore externality costs of around $1 per gallon at the retail level appear to be in the right range, although uncertainties are great and analysts disagree.

[9] In this context, it should be noted again that oil itself is subsidized, since consumers of gasoline and diesel do not pay for many of the externality costs of oil.

6. Should incentives phase out?

Yes, although while subsidies for alcohol fuels and electric vehicles can be reduced over time they probably cannot be eliminated while leaving alcohol and electric at price parity, even at large, cost-efficient scales, with current prices. However, initial subsidy levels are higher than should be needed in later phases, and the reduction of subsidies should occur as production scale increases and technologies improve.

7. Should a program have mostly centrally directed regulatory requirements, or should it be based on market-based approaches?

Generally, mainland programs have attempted to use a mix of requirements and incentives because requirements (such as EPACT fleet purchase requirements) establish certain future conditions on which the private sector may base investment decisions, while incentives provide a valuable supplement to help achieve cost reductions and optimum approaches. A mixed program may be desirable for Hawaii for the same reasons. Some requirements would ensure the pace of the program and provide investor confidence.

8. Should the program focus on the supply of AFVs and alternative fuels, or on the demand of consumers for such vehicles and fuels?

The most successful programs have elements that address both supply and demand. Those providing the supply appreciate help in stimulating demand, and those addressing the demand expect help in assuring supply.

10.3.2 GENERAL DISCUSSION OF MEASURES

10.3.2.1 GENERAL COMMENTS ON ALTERNATIVE FUEL AND VEHICLE MEASURES

Measures to encourage the use of alternative transportation fuels are generally intended to reduce or eliminate the barriers to adoption, shown in Table 10-7, which are faced by the alternative fuels.

Table 10-7.
Barriers Facing Each Alternative Fuel

Fuel	Barrier	
Alcohol	• Infrastructure • Relatively Few Vehicles Suitably Equipped	• Fuel Cost • Consumer Acceptance
Electric	• Vehicle Cost • Infrastructure	• Consumer Acceptance • Standardization
Biodiesel	• Lack Of Locally-Relevant Cost & Production Information	• Fuel Cost • Consumer Acceptance
Propane	• Vehicle Conversion Cost • Fuel Availability	• Consumer Acceptance

10.3.2.2 CATEGORIZATION OF POTENTIAL MEASURES

Potential measures, summarized in Table 10-8, are grouped by type: alternative fuel supply measures, alternative fuel vehicle measures, outreach/education measures, and governmental activities.

Table 10-8.
Potential Hawaii Alternative Transportation Fuel Measures

Type of Measure		Description
Alternative Fuel and Alternative Fueled Vehicle Measures (A)		**Fuels**
	A.1	(*) Alcohol / oxygenate blend requirement for gasoline
	A.2	(*) Address infrastructure issues confronting alcohol and electric
	A.3	(*) Ethanol blending in diesel
	A.4	(#) Special fund for alternative fuel incentives
	A.5	(#) Increase taxes on gasoline and diesel
	A.6	(#) Adjust other fuel taxes on the basis of energy content
	A.7	(#) Alcohol production incentive and alternative fuel property tax exemption
	A.8	(#) Selective state co-investment
	A.9	(#) Selective state loans
	A.10	(#) State purchase and distribution of small volumes of alcohol
	A.11	(#) Periodic report on alternative fuel introduction
	A.12	(#) Reduce alternative fuel costs that are within governmental control
		Vehicles
	A.13	(*) Establish fleet purchase requirements
	A.14	(*) Government Vehicle Allowances
	A.15	(#) Alternative fuel incentive on government contracts
	A.16	(*) Non-discriminatory insurance treatment
	A.17	(#) Special fund for AFV incentives
	A.18	(#) Registration fee surcharge on conventional vehicles
	A.19	(#) AFV purchase/conversion incentives
	A.20	(#) Periodic report on AFV introduction
Outreach and Education (O)	O.1	Continue dialogue with fleet managers
	O.2	Public education
	O.3	Train AFV technicians
	O.4	Loaner AFV program
Governmental Activity (G)	G.1	Encourage full funding of EPACT and EO #12844
	G.2	Address implementation of Act 199, Ethanol Mandate
	G.3	Maintain effective communications with the legislature
	G.4	Work to achieve consensus on an Omnibus Transportation Energy Bill
	G.5	Ensure Hawaii participation in the EV "Infrastructure Working Council"

(*) = Requirement.(#) = Incentive.

Certain measures would require statutory authorization, and for discussion purposes the title "Energy Resources Coordinator" is used as the official responsible for the administration of the program.

10.3.3 INDIVIDUAL MEASURES

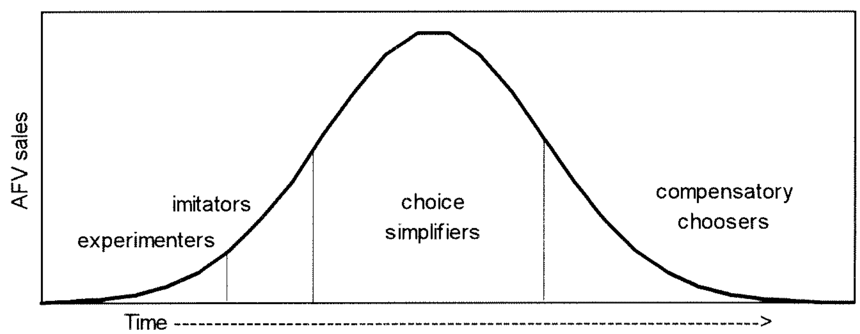
10.3.3.1 ASSUMPTIONS USED IN EVALUATIONS

Estimates of future energy demand are from Chapter 2. Fuel prices at the pump are from Chapter 8. Estimates of alternate fuel vehicle technology adoptions are based on a variety of sources, including work in progress in California (Kavalek, 1995; Turrentine and Sperling, 1992; Train, 1986; Davis, 1995).

Attributes considered in vehicle choice are vehicle price, vehicle range, top speed, acceleration (0-60 mph), luggage space, service station availability, fuel cost, service station refueling time, home recharge time, and vehicle emissions (if attributes for all vehicles are identical, probability of choice of any one will be the same as probability of choice of any other). A vehicle availability factor (what percentage of all the vehicles available are capable of operating or being converted to operate on the alternative fuel) is then applied to the choice probability.

Adoption of new technology is assumed to follow a diffusion process for AFVs (see Figure 10-5) in which early purchasers are experimenters (or, in an environmental consumer market, "moral choosers"), followed by imitators ("social choosers"), and finally (once information on fuels and vehicles has become widely available), choice simplifiers and compensatory choosers.

Figure 10-5.
Diffusion Process for AFVs



Source: Turrentine and Sperling, 1992.

In other words, even if alternative fuel vehicles are available with costs and attributes identical to conventionally-fueled vehicles, consumers unfamiliar with the alternatives will not purchase the new technology. As consumers become more familiar with the alternatives, acceptance will increase; this process of information and technology diffusion will eventually result in consumer behavior which is constrained essentially by vehicle availability, vehicle attributes, and price.

All fleet purchase requirements of the Energy Policy Act of 1992 are included in evaluations. Vehicle and fuel prices are in constant dollars. For more detail, see Appendix A-4.

10.3.3.2 THE "FUTURE NO ACTION" CASE

The "future no action" case assumes that none of the measures discussed below are active. All of the potential alternative fuels are assumed to be available. All fleet purchase requirements of the Energy Policy Act of 1992 are included. The percent of rental cars assumed to resold and retained in the state is 10%. There is no ethanol blending, no adjustment of fuel taxes, no public education efforts by either public or private entities, (except as specifically stated in respective measure evaluations) and all prices are in constant dollars.

10.3.3.3 ALTERNATIVE FUEL MEASURES

The following measures were considered as potential means of promoting alternative fuels and alternative fueled vehicles.

A.1 Alcohol or Other Oxygenate Blend Requirements for Gasoline

A requirement for gasoline to contain alcohol or other oxygenates may take one of two forms: as an alcohol requirement, or as an oxygenate requirement.

One of the primary differences between an alcohol content requirement and an oxygenate requirement is in the requirement's stated objective. With an alcohol content requirement, the intent of the requirement is for alcohol to be used as fuel. The requirement, therefore, may be flexible as long as the goal - use of a certain amount of alcohol as fuel - is met. For example, consider a 5% blending requirement. One possible approach, rather than 5% across the board, would be to have a 10% blend in some gasolines, a 5% blend in others, and possibly 0% in the rest, as long as the overall alcohol use would be the same as a statewide 5% blend. This approach would give consumers a choice and refiners and marketers some flexibility in their distribution and marketing. An oxygenate requirement, on the other hand, would require a certain oxygen content in all the fuel. If ethanol was to be the oxygenate in a 2% oxygen content requirement, for example, all gasolines would contain 5% ethanol. There would be limited opportunity, if any, for gasolines to have 10% ethanol or 0% ethanol, thus allowing even less choice for consumers, refiners, or marketers.

Another potential difference between an alcohol content requirement and an oxygenate requirement is in state excise tax revenues. Since 10% ethanol blends are eligible for the excise tax exemption, and 5% blends are not, the alcohol blending requirement would cost the state more in uncollected excise taxes if the required use of ethanol fuels was made up primarily with 10% blends. Cost estimates for alcohol content requirements assume the highest cost case, i.e. the maximum amount of 10% blends. Cost estimates for oxygenate requirements assume that none of the blends are eligible for the excise tax exemption.

A1a Alcohol Content Requirement

Hawaii could adopt regulations requiring that gasoline sold in Hawaii must contain a certain percentage of alcohol, with discretion by the Energy Resources Coordinator to lower amounts to zero if adequate supplies are not locally available at competitive prices.

Such a measure could create an immediate demand at a scale which could potentially make local fuel production cost-effective. With current gasoline demand in the range of 380 million gallons of fuel, a 10% ethanol blend in 50% of the gasoline would create a demand for about 19 million gallons of ethanol. Or, a 3% methanol blend in 50% of the gasoline would create a demand for about 6 million gallons of methanol. The ethanol or methanol could also be converted into ethers methyl tertiary butyl ether (MTBE) or ethyl tertiary butyl ether (ETBE).

Since interstate commerce laws do not allow states to enact laws inhibiting the free flow of products between states (i.e. there can't be a requirement that gasolines contain only "Hawaii-produced" alcohols), Hawaii-produced alcohol will have to compete with alcohol or ethers from outside the state.

Current state law allows for gasoline blended with 10% biomass-based alcohol to be exempt from the 4% tax on retail sales; the value of this incentive is about 4 cents per gallon of blended fuel.[10] If it appears that out-of-state producers would benefit from the exemption, Hawaii could consider enacting a producer incentive (see Measure A-7).

Impact: Three levels of alcohol blending in gasoline (5%, 7.5%, and 10%) were assessed. Next to fleet mandates, this measure resulted in the highest projected gasoline and diesel displacement of all the measures tested - 3.1%, 4.7%, and 5.3% greater displacement of gasoline and diesel than the "future no action" case. (Even with these amounts of "displacement," the total projected demand for gasoline and diesel in 2014 is greater than total demand in 1994).

This measure also has a small secondary effect on the relative attractiveness of M85 and E85 vehicles. By creating an instantaneous demand for several million gallons of alcohol fuel (i.e. by going directly to the "phase 3" level of alcohol production), the relatively high M85 and E85 fuel costs of alcohol phases 1 and 2 are avoided. This results in about 5% more alcohol vehicles with this measure active than in the "future no action" case.

A1b Oxygen Content Requirement

Hawaii could adopt regulations requiring that gasoline sold in Hawaii must contain a specified percent oxygen by weight,[11] with discretion by the Energy Resources Coordinator to lower amounts to zero if adequate supplies of oxygenates (including ethanol, methanol, and ethers) are not locally available at competitive prices.

The effect of this measure would be to require the use of oxygenates (such as ethanol, methanol, ethanol- or methanol- based ethers, or other oxygenates) in gasoline. Oxygen content requirements could be met in several ways, as shown in Table 10-9. A 2% oxygen requirement could be met with methanol at 3.8%, ethanol at 5.5%, MTBE at 11.1%, or ETBE at 12.9%.

There are other oxygenates, such as tertiary amyl ethyl ether (TAME) and tertiary butyl alcohol (TBA), which are not manufactured from ethanol or methanol but which would meet the oxygenate requirement.

[10] This incentive is available regardless of where the ethanol used in the gasoline is produced. Some other states have changed their ethanol incentives to be at the point of production rather than at the point of sale, so that only their in-state ethanol producers are receiving the incentives.

[11] EPA regulations do not permit gasolines to contain more than 2.7% oxygen by weight, except for ethanol blends which are limited to 3.5% oxygen by weight.

Table 10-9.
Potential Use of Alcohols and Ethers in Oxygenates

ALCOHOLS			ETHERS		
	Methanol	**Ethanol**		**MTBE**	**ETBE**
%O by wt: 2%			%O by wt: 2%		
% alcohol by volume:	3.8%	5.5%	% ether by volume:	11.1%	12.9%
%O by wt: 2.7%			%O by wt: 2.7%		
% alcohol by volume:	5.1%	7.4%	% ether by volume:	15.0%	17.4%
ALCOHOL USED IN PRODUCTION OF ETHERS					
Methanol in MTBE			**Ethanol in ETBE**		
Gallons methanol / gallon MTBE:		0.338	Gallons ethanol / gallon ETBE:		0.42
%O by wt: 2%			%O by wt: 2%		
% methanol in MTBE gasoline		3.8%	% ethanol in ETBE gasoline		5.4%
%O by wt: 2.7%			%O by wt: 2.7%		
% methanol in MTBE gasoline		5.1%	% ethanol in ETBE gasoline		7.3%

An oxygenate requirement resulting in a 5% alcohol blend (i.e. a 2.0% requirement met with ethanol or ETBE or a 2.7% requirement met with MTBE) was assessed. As with the 5% alcohol blending requirement, this measure resulted in 3.1% greater displacement of gasoline and diesel than the "future no action" scenario. Even with these amounts of "displacement," the total projected demand for gasoline and diesel in 2014 is greater than total demand in 1994.

A.2 Infrastructure Issues Confronting Alcohol and Electric

These measures address the infrastructure issues that impede introduction of the alternative fuels.

A.2.a Infrastructure Development Requirements for Alcohol Fuels

There could be regulations requiring that at least one new or replacement underground tank at commercial and government fueling facilities be compatible with alcohol. Government would develop equipment specifications and guidance to make this program cost-effective and uniform. The State of Hawaii could work with fuel distributors, dispensing equipment manufacturers, vehicle manufacturers, the State of California and the federal Clean Fuels Implementation Task Force to develop consistent hardware specifications.

At the time of installation of new or replacement storage tanks, alcohol-compatible equipment can be chosen at little or no incremental cost. The South Coast Air Quality Management District in California currently has a rule of this type, and the California Energy Commission provides sample equipment specifications. The tank turnover and removal rate in Hawaii is currently quite high, and as additional Federal regulations come into effect (for example, corrosion protection and spill/overflow protection requirements in 1998) (Kwan, 1995), installers of new tanks may voluntarily opt for double walled stainless steel to reduce liability and insurance costs. Double-walled stainless steel tanks are fully alcohol-compatible.

Compared to the "future no action" scenario, this cost element translates into a difference of 6 cents per GEG and an increase in projected 2014 displacement of gasoline and diesel by alcohol of 0.9%.

A.2.b Infrastructure Development Requirements for Electric Vehicles

A.2.b.1 New Construction EV Recharging Requirement

Hawaii Standards for New Construction Could Require the Provision of Recharging Infrastructure for Electric Vehicles.

At the time of new construction is the lowest cost opportunity to provide electric-vehicle charging infrastructure. Since charging standards have not been established, the requirement could be limited at present to the installation of "raceways," trays or tubes through which cable can be pulled later. Not all structures need to be included, but key structures include parking facilities, condominium and apartment complexes, and single family dwellings. Guidance documents and standards, even if not mandatory, would be helpful in developing a uniform infrastructure.

The "Infrastructure Working Council" is reported to be close to agreement on conductive charging standards (220V, 40A and 110V) with defined interfaces. A corresponding standard for inductive charging remains elusive.

Since some EV charging systems use standard 110-V residential service, this requirement would be expected to have little direct impact on the numbers of electric vehicles in use in the near term. This type of standard is more likely to be a secondary effect of a widespread demand for EVs rather than a driver of demand for EVs. However, in the event that "electrical service suitable for EVs" was different from standard 110-V residential service, and a requirement for such service was applied to all new single-family residential construction, the impact would be equal to the number of new single-family residences constructed, or approximately 4400 - 6800 statewide per year (DBEDT, 1994).

A.2.b.2 Off-Peak Recharging For Electric Vehicles Available At A Reduced Rate

Reduced rates for off-peak electric vehicle recharging could be proposed by the electric utilities and approved by the Public Utilities Commission.

Since off-peak and off-grid charging of electric vehicles is desirable from a load management standpoint, and off-peak charging is preferable to on-peak charging, rates and systems which are designed to maximize off-peak and off-grid charging of electric vehicles could result in both reduced costs for electric vehicle recharging and in increased public awareness and support of electric vehicles.

Impact: off-peak recharging rates, and the use of recharging equipment and/or timers supplied by the electric utility, results in a projected reduction in electricity cost per mile of up to 66% and an increase in the projected 2014 displacement of gasoline and diesel by electricity of 25%.

A.2.b.3 Rate Payer Support for Electric Vehicle Recharging Infrastructure

The Hawaii Public Utilities Commission could allow electric utilities to put into the rate base their costs for public and private recharging infrastructure, electric

battery change out and/or charging facilities and vehicle batteries that are owned by them.

This measure financially supports electric vehicles as they benefit the utility through better load profiles and more efficient power transmission. Utilities would include specific proposals in their applications for rate approvals. The applications would include detailed justifications based on future rate payer benefits.

Although not specifically evaluated at this time, once the electric utilities have developed cost estimates, the impact and effectiveness of this type of measure may be estimated using analysis tools such as those developed in this project.

A.2.c Public Access to Government Fueling Facilities

State and local government facilities that supply alternative fuels could be available to the public, and Hawaii could work with the federal government to provide public access to federal facilities that dispense alternative fuels.

Due to EPACT and Executive Order (EO) 12844 requirements, governments will be establishing facilities to provide alternative fuels to their fleets. Providing public access to these facilities in the early phase of an alternative fuel program would increase the public's willingness to purchase AFVs during the time that private sector alternative fueling facilities are limited in number. Fueling systems are expensive and should serve the maximum number of vehicles possible until alternative fuel and infrastructure becomes more widespread. The federal government is working to revise constraints that limit federal fueling facilities to government fleets. Public access to alternative fueling facilities are features in some Clean Cities programs (e.g. Washington, D.C.).

A.3 Ethanol blending in diesel ("diesohol").

Ethanol could be blended in amounts up to 30% in diesel fuel.

Effect would be to increase use of alcohol fuels. Impact: 5% alcohol in diesel results in a projected increase in 2014 alcohol use of 14% over the "Future no action" scenario; 10% alcohol in diesel results in a projected increase of 28%; and 30% alcohol in diesel results in a projected increase of in 2014 alcohol use of 84% over the "future no action" scenario.

A.4 Special Fund for Alternative Fuel Incentives

Hawaii could establish a special fund ("Alternative Fuel Incentive Special Fund") which would receive revenues from the taxes described in Measure A.5 and from returns of capital, dividends, and interest earned from investments and loans made pursuant to Measures A.8 and A.9.

Since revenues are needed to fund the alternative fuel incentives, funds collected for the alternative fuels program could be separated from the general fund, so that the revenues could be directed to specifically support alternative fuel programs.

Measures A.5, A.8 and A.9 describe the sources of revenues to fund the incentives. The fees would be scaled to program needs.

A.5 Increase Taxes on Gasoline and Diesel Fuel

Hawaii could increase taxes on gasoline and diesel. Funds would be deposited in the Alternative Fuel Special Fund. Hawaii could reauthorize the added taxes after about 6 years based upon a review of the uses of the funds and the effectiveness of the alternative fuel incentive programs (see Measures A.11 and A.20).

The increase in taxes, if any, is not expected to be a disincentive to continued use of gasoline and diesel fuel (for example, fully funding importation and production of alcohol fuel for use in high level blends would require less than one tenth of one cent per gallon for the first ten years). Impact from an energy standpoint, therefore, is equal to the impact of whatever incentives are funded by this measure. These fees and taxes are scaled to supply funds needed to support alcohol production (see Measures A.7, A.8, A.9, and A.10). Funds could also be available to support the electric vehicle program.

A.6 Adjust Other Fuel Taxes on the Basis of Energy Content

Hawaii could ensure that state and local highway taxes on motor fuels would be on an energy-equivalent basis.

This would remove a disincentive to alternative fuels while maintaining the amount of revenue received by the state highway fund from state highway taxes. Since this measure does not require revenue from any other sources, it would be logical for this recommendation to be implemented prior to any other revenue related measures. Impact of this measure on fuel prices is 27¢ per GEG for M85, 16¢ per GEG for E85, and 20¢ per GEG for E100.

A.7 Alcohol Production Incentive

Hawaii could establish a producer payment for local producers of alcohol fuels.

At current gasoline prices and with the costs projected in this study, it appears that alcohol fuel production incentives would be necessary in order for high-level alcohol blends (E85, M85, E100, M100) to be attractively priced; lower-level alcohol blends (E10) may also benefit from production incentives, depending on the situation. Alcohol producer incentives for high-level and low-level blends are discussed separately below.

A.7.a Alcohol Producer Incentive for High Level Blends (M85 and E85)

The "high level alcohol blend producer payment" scenario evaluates the impact of payments to local producers (or importers, in phases 1 and 2) in amounts sufficient for alcohol fuels to be competitive (on a GEG basis) with gasoline costs at the pump. Rates are adjusted by alcohol phase (see Table 10-2) to correspond with expected cost decreases associated with larger alcohol plants.

Note: the "producer payment" is not a "tax credit." The ability of a traditional "tax credit" to provide the necessary level of subsidy is questionable, since tax credits are only applicable to the amount of tax owed. If an alcohol producer has a tax liability which is less than the amount of "tax credit" for which he is eligible based on the production of fuel alcohol, then he does not receive the full value of the tax credit.

For example, consider the scenario in which a subsidy of 61 cents per gallon of ethanol is required in Phase 3 for E85 to compete with gasoline at the pump. A tax credit of 61 cents would not provide that amount of support. In order for the alcohol producer to receive $0.61 in tax credits per gallon of alcohol produced, with a production cost of[12] $1.40 per gallon, the producer would have to owe $0.61 per gallon in state income taxes. The only way he'd owe that much in state taxes (assuming 6.435% state tax rate on corporate taxable income) is if he made a net profit of $9.48 per gallon (i.e. he'd have to sell it for at least $10.88). If the alcohol could be sold for that much, a production incentive wouldn't be necessary. Therefore, a production incentive would have to be either a direct payment to the producer or some form of marketable tax credit which could be sold by the producer to an entity which would be able to use the tax credit certificate to offset taxes owed.[13]

Impact: subsidizing the M85/E85 fuel to be the same price per GEG as gasoline translates into a difference in alcohol fuel price of $1.70 per GEG (to start), $1.10 per GEG (2001-2012), and $0.92 (2012-2014). In order to fund this measure, a tax of $0.001 (until 1999), $0.002 (2000-2002), $0.007 (2002-2005), $0.013 (2006-2009), and $0.020 (2010-2012) per gallon of gasoline and diesel would provide the necessary revenue.

Note: if a scenario includes both low-level ethanol blending (as in Measure A.1), and alcohol producer payments designed to subsidize alcohol production so that M85 and E85 fuel are the same price as gasoline, program costs rise substantially. This is discussed further in the next section.

A.7.b Alcohol Producer Incentive for Low Level Blends (E10)

As shown in Table 10-10, projected low-level ethanol blend costs range from a low of $1.46 to a high of $1.71. The range of costs are due to variations in the cost of the ethanol; since the ethanol is only 10% of the total fuel, an observed difference of 1 cent indicates that the ethanol price difference is about ten cents. Therefore, if the ethanol blend is one cent more than the non-blended gasoline, a subsidy of ten cents per gallon of ethanol would be required; likewise, of the ethanol blend is three cents more, a subsidy of thirty cents would be required. If the ethanol has a "negative" subsidy (i.e. profit-making potential) of ten cents, that translates into one cent difference in blended fuel price at the pump.

Producer incentives geared towards making E10 competitive with non-ethanol-blended gasoline or with mainland ethanol would be determined based on the scale of production and demand. The tools developed in this project can be used to provide a general evaluation for a specific situation. Producer credits for E10 were not explicitly evaluated here (results would be similar to Measure A.1.a).

A.8 Selective State Co-Investment

The state could co-invest up to 40 percent ownership in alcohol production facilities, alcohol distribution infrastructure, and electric vehicle manufacturing or conversion or battery recycling facilities placed into service after a certain date. Investment funds would be drawn from the Alternative Fuel Special Fund. Dividends and distributions of capital and other payments would be deposited in the Alternative Fuel Special Fund.

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[12] low end: $0.78; high end: $2.02; mid-range: $1.40

[13] Kansas, Missouri, Nebraska, South Dakota, and Minnesota have "direct producer incentives" of 20 cents per gallon for fuel ethanol produced in their respective states. The Minnesota incentive increases in 1995 to 25 cents per gallon, not to exceed $3.75 million per producer per year. Montana has a 30 cent per gallon producer payment for ethanol produced in the state.

Table 10-10.
Alcohol Production Incentives for Ethanol for Use in E10

PHASE	SCENARIO	$/gal E10 (low end)	$/gal E10 (high end)	$/gal gasoline	Subsidy (1) for midrange to be competitive	ACRES	# OF JOBS
1	Ethanol (6000 gpy, containerized) Shipped from Mainland, Sold as E10 (E1b)	$1.66	$1.71	$1.62	$0.61	0	0
1	Ethanol (170000 gpy, containerized) Shipped from Mainland, Sold as E10 (E1b)	$1.62	$1.66	$1.62	$0.17	0	0
2	Ethanol (7 mgpy) from Waste on Oahu, Sold as E10 (E2b)	$1.48	$1.60	$1.62	($0.82)	0	17
2	Ethanol (1 mgpy) from Molasses, Shipped to Oahu, Sold as E10 (E3b)	$1.61	$1.67	$1.62	($0.96)	0	2
2	Ethanol (3 mgpy) from Molasses, Shipped to Oahu, Sold as E10 (E3b)	$1.53	$1.56	$1.62	$0.22	0	7
2	Ethanol (7 mgpy) Produced from Sugarcane on Oahu, Sold as E10 (E4b)	$1.51	$1.65	$1.62	($0.74)	3,420	400
3	Ethanol (30 mgpy) from Waste on Oahu, Sold as E10 (E2b)	$1.46	$1.58	$1.52	$0.50	0	73
3	Ethanol (30 mgpy) Produced from Sugarcane on Oahu, Sold as E10 (E4b)	$1.49	$1.63	$1.52	$0.35	14,655	1,714

(1) $/gal 100% alcohol

State co-investment may be a useful supplement to tax credits for fuel production and distribution because not all production and distribution facilities would generate profits against which credits may be taken. This difficulty faces the federal alcohol mixtures credits and pure alcohol credit as discussed in Chapter 8. Therefore other state assistance may be helpful in the early years of the program. The state may wish to develop criteria for making investment decisions and/or conduct competitive funding programs. The state may also wish to sell or liquidate investments after a period.

For an alcohol production facility with capital costs of $92 million and production capacity of 30 million gallons per year, a direct investment of 10% of facility cost could translate into a difference in fuel production cost of 3 cents per alcohol gallon, or 6 cents per gasoline equivalent gallon.

Outright grants may occasionally be appropriate to cover such items as capital costs at retail alcohol facilities, especially if existing equipment is not compatible with high level blends, or if new tanks need to be installed. This option may need to be used in the early years. It has proven essential in the California program, where grants of up to $30,000 have been extensively used for the first 50 methanol outlets. Grants are the simplest and most effective way to enlist the support of the fuel retailers.

A.9 Selective State Loans

The state could offer from the Alternative Fuel Special Fund low-interest loans for alcohol production facilities and electric vehicle manufacturing, conversion or battery recycling facilities up to an amount that matches commercial and private

loans for the facility. Payments of interest and repayments of principal would be deposited in the Alternative Fuel Special Fund.

This assistance could be a useful supplement to other alcohol incentives. As with investments, the state may wish to develop criteria for making loans and conduct competitions for available funds.

A.10 State Purchase and Distribution of Small Volumes of Alcohol

Using the Alternative Fuel Special Fund, the Energy Resources Coordinator could purchase small volumes of alcohol for bulk facilities or retail stations to ensure that alcohol vehicles could purchase fuel during the early years of the program. The Energy Resources Coordinator would establish a price for this government-supplied fuel at levels low enough that terminals and retailers could provide alcohol fuels at prices competitive with gasoline or diesel fuel and still earn a reasonable margin. The Energy Resources Coordinator would not provide alcohol fuel under this program if alcohol production incentives were being paid for volumes adequate to supply the alcohol fuel demand in any year.

This element could provide alcohol fuels to early vehicles when local production may not be adequate. Alcohol vehicles cannot be marketed successfully if some alcohol fuel is not conspicuously available. This approach would be most appropriate in the situation where local demand for alcohol fuels is less than could support a local production facility (i.e. less than three to seven million gallons per year). Funds collected from the fuel tax (amounts would be identical to the "producer payments without ethanol blending" scenario discussed above) would be used for purchasing alcohol from out of state, with the intent that once the demand for alcohol fuels increased to the point where a local industry could be supported, the funds would be used for payments to local producers. Impact on fuel use over the period of government involvement would be similar to impact of other measures subsidizing the cost of alcohol.

A.11 Periodic Report on Alternative Fuel Introduction

Every two years after the initiation of the fuel incentive program, the Energy Resources Coordinator could report to the legislature on the disposition of funds from the Fuel Incentives Special Fund, the surplus in the Fund, the technologies receiving incentives and support, the numbers of AFVs receiving incentives, incentives requested that could not yet be funded, the technologies being introduced into the vehicle population, the types and amounts of alternative fuels being produced and used in Hawaii (including blends), the amount and net costs of alcohol fuel supplied by the state, and the effectiveness of the incentives in influencing the production and use of alternative transportation fuels in Hawaii. The Energy Resources Coordinator could recommend changes needed to the fees and incentives to achieve the displacement and fuel mix objectives.

The authorizing legislation should allow some discretion to the Energy Resources Coordinator and anticipate the possible need for mid-course changes. The advice of the Energy Resources Coordinator, based on program experience, should be available during consideration of program changes. This measure should be coordinated with A.20.

Portions of the report could be made available to the public and media as well. This, in combination with other "public awareness" measures, is projected to result in a reduced length of time for the acceptance of the new vehicle technologies. See Measure O.2.

A.12 Reduce Alternative Fuel Cost Components That Are Within Governmental Control

The state has control over some of the cost components of the price of alcohol at the pump. For example, an alcohol marine terminal could be located on land leased from the state. Discounts on the rent would help decrease the delivered price of the alcohol.

10.3.3.4 ALTERNATIVE FUELED VEHICLE MEASURES

The following measures should be considered if Hawaii wishes to increase the number of AFVs in use.

A.13 Establish Fleet Purchase Requirements

Hawaii could require fleets to purchase AFVs when adding or replacing vehicles. Fleet requirements for fleets other than state government fleets could be determined through a rule making process. The purchase requirements could be in excess of those imposed by EPACT and apply regardless of whether there are incremental vehicle or fuel costs.

The "aggressive" scenario of Chapter 4 assumes private and rental fleets purchase large numbers of AFVs and resell some portion of them within the state. Local rule making would include assessment of factors such as model availability, retail prices, and resale practices. California's experience indicates that rental companies can accept alcohol vehicles, but the period of mutual education between government agencies and rental companies has covered several years. Furthermore, the rental companies are currently exempted from EPACT requirements and have strongly resisted rule requirements for fear of being dragged into EPACT requirements. Rental company elements of the program could perhaps begin with incentives only. (For an evaluation of incentives, see Measure A.19.)

A fleet purchase requirement could also include a purchase requirement for EVs, to be phased in after the completion of the HEVDP. In particular, government and electric utility fleets may be appropriate targets of an EV purchase requirement.

Requirements for heavy-duty fleets could also be developed by rule making since the number of alternative-fuel heavy-duty engines is currently limited and special circumstances (such as operational requirements for TheBus) need to be addressed. The heavy-duty rule could be revised at frequent intervals as commercial alternative-fuel engines become more common.

<u>A.13.a Establish alternative fuel purchase requirements for state fleets.</u>

Administrative Directive 94-06 directs that 25 percent of motor vehicles acquired (for state government use) in model year 1998 shall be alternative-fueled vehicles. Although this results in an accelerated purchase of vehicles for the first few years, by 2014 the EPACT-required purchases in the "future no action" scenario have almost completely overshadowed state requirements (the net difference in 2014 in number of AFVs due to the state-mandated 25%

level of AFV purchase is 1.2%). A state-mandated level higher than EPACT requirements, however, would show a larger difference.

A.13.b Establish alternative fuel purchase requirements for county fleets.

Although not quantified, county governments could acquire alternative fuel vehicles in excess of those required by the National Energy Policy Act of 1992. The model which has been developed is capable of estimating costs and impacts of various levels of alternative fuel light duty vehicle purchases.

A.13.c Establish alternative fuel purchase requirements for rental and other private fleets.

The National Energy Policy Act of 1992 contains mandates for certain fleets; those mandates are included in the "future no action" scenario. Whereas EPACT fleet mandates apply only to "covered fleets," for the purposes of this evaluation it was assumed that state mandates, shown in Table 10-11, would apply to all rental and private non-rental fleets containing more than ten vehicles.

Fleet mandates alone (no fuel or vehicle incentives), assuming 100% compliance,[14] result in overall displacement of gasoline and diesel in 2014 of 15%, as compared to the "future no action" case of 5%.

Table 10-11.
Fleet Mandate Rates Used for Measure A.13.c

Year	Rental fleets	Private non-rental fleets	EPACT
	percentage of new vehicles required to be AFVs:	percentage of new vehicles required to be AFVs:	requirement for non-government "covered fleets"
1995	0%	0%	0%
1999	5%	20%	20%
2003	10%	40%	40%
2007	20%	70%	70%
2009	25%	70%	70%
2011	30%	70%	70%
2015	40%	70%	70%

The cost to fleets could be significant if the vehicles and / or fuels are more expensive than their gasoline counterparts - with the scenario assumptions, for example, the additional cost in 2014 is estimated at $214 per alternative fuel vehicle (vehicle purchase cost plus fuel cost).

A.13.d Establish purchase requirements for heavy duty vehicles.

Although purchase requirements for heavy duty vehicles were not specifically evaluated in this study, heavy duty vehicles could utilize significant amounts of alternative fuels. Evaluation of the potential cost and potential fuel use by heavy duty vehicles would require that a heavy duty vehicle component, including information on replacement rates, range and engine size requirements, and engine availability and cost, be added to the bus component currently in the model.

[14] A state mandate requiring private fleets (rental and non-rental) to purchase alternative fuel vehicles would involve a variety of issues.

A.14 Government Vehicle Allowances

State and local government allowances for vehicle leasing by government employees could be provided only for AFVs, and employees choosing gasoline or diesel vehicles would not receive an allowance.

Government officials driving non-fleet vehicles could be conspicuous participants in an alternative fuel program, especially if fleet purchase requirements are adopted. This would contribute to "public awareness" (see Measure O.2).

A.15 Alternative Fuel Incentives on Government Contracts

The evaluation process of bids for government contracts could include provisions to reward those bidders that provide evidence of an effective program to purchase AFVs and use alternative fuels.

This kind of program is being implemented by cities in the Coachella Valley of California as part of a broad alternative fuels program. It appears to be quite effective in publicizing the program and increasing the number of AFVs. Requirements and approaches in Hawaii would be developed locally. The preference could be similar to that for minority or disabled veteran employment or "small businesses."

Where government agencies obtain rental cars under a contract arrangement, a suitable incentive could be applied to daily rental fleets bidding for government business.

A.16 Non-Discriminatory Insurance Treatment

Hawaii could prohibit insurance surcharges on AFVs until statistical data are available to support extra premiums.

Insurance companies sometimes approach AFVs with conservatism. This can discourage a program significantly by adding extra costs and could be avoided until data are available to justify higher premiums. This may require state regulation.

A.17 Special Fund for AFV Incentives

Hawaii could establish a Special Fund ("Alternative Fuel Vehicle Special Fund") to encourage the purchase of alternative fuel vehicles.

Financial incentives would assist vehicle manufacturers, dealers, and fleets, particularly in early years, when the number of AFVs is small and their costs may exceed gasoline and diesel vehicles. In the early years it may be possible to manage the program solely on the basis of incentives rather than requirements to purchase AFVs. A special fund could be set up to finance the incentives.

The intent of this measure is to increase voluntary procurement of alternative fuel vehicles by reducing the costs of alternative fuel vehicle ownership. Impact: see Measure A.19.

A.18 Registration Fee Surcharge on Conventional Vehicles

Hawaii could establish a registration fee surcharge on all gasoline and diesel vehicles. Receipts would be deposited in the Alternative Fuel Vehicle Special Fund.

Hawaii could require that the surcharge be reauthorized after 6 years after a review of reports describing the sources and uses of funds (see Measures A.11 and A.20).

The increase, if any, in registration fee is not expected to have any measurable impact as a direct disincentive to continued purchase of gasoline and diesel vehicles. Impact, therefore, is equal to the impact of whatever incentives are funded by this mechanism (see Measure A.19). Funding requirements may be estimated based on fuel and vehicle availability and cost.

A.19 AFV Purchase/Conversion Incentives

Out of the Alternative Fuel Vehicle Special Fund, Hawaii could provide financial incentives to purchase AFVs. The incentive for light-duty and medium-duty alcohol vehicles up to 33,000 pounds could be $500 per vehicle. For heavy-duty alcohol vehicles above 33,000 pounds the incentive could be $5,000 per vehicle. The incentive to purchasers of electric vehicles could be $2,000 per light-duty and medium-duty vehicle (battery or fuel cell) up to 33,000 pounds and $5,000 for larger vehicles. A rebate of $1,000 could be provided to those who convert a gasoline or diesel vehicle to dedicated battery-electric or fuel-cell drive, if the fuel cell uses alcohol or hydrogen. Hawaii could provide an extra $500 rebate for the purchase of new light-duty AFVs to those who retire pre-1980 light-duty gasoline vehicles.

Alcohol vehicles are generally offered by manufacturers at prices equal to equivalent gasoline-only models. However, a financial incentive is helpful, especially in association with fleet purchase requirements, since fleets may have to buy different models than they might have preferred depending on the alcohol-capable models being offered. Furthermore, manufacturers prefer to see state support for alternative fuel programs, partly as a way to recruit the enthusiasm and active participation of dealers. California has been providing $400 and $500 incentives recently for alcohol passenger vehicles, which has seemed to be adequate, or even perhaps slightly more than necessary to meet the objectives. Large vehicles with diesel-type heavy-duty engines need larger incentives due to the higher costs of these engines, the small volumes, and the relative immaturity of the alcohol technologies in heavy-duty engines.

The needed incentives for electric vehicles are difficult to gauge due to their rapid development. The incentives provided by EPACT are already significant and additional incentives may be available through utility programs (see Measure A.2.B.2). For electric vehicles in the near term, an incentive for conversions is helpful also.

Unlike the alcohol producer incentive, which is set equal to whatever amount is necessary for alcohol fuels to be cost equivalent with gasoline, the vehicle purchase / conversion incentive is an amount which may be more or less than the cost differential between alternative fuel vehicles and their gasoline counterparts.

All incentives were modeled with the following phase-out schedule:

Table 10-12.
Phase-Out Schedule Used for Vehicle Purchase Incentives

Phase	From (year)		To (year)	% of original credit
1	1995	-	1999	100%
2	1999	-	2002	75%
3	2002	-	2005	50%
4	2005	-	2009	35%
5	2009	-	on...	0%

Phase-out schedules may be adjusted, based on incentive levels and projected vehicle purchase numbers, to maintain program (and funding) balance. In an aggressive program (rather than the "incentives only" scenario modeled here) with widely-available alternative fuel vehicles, attractively-priced alternative fuels and fleet mandates, the phase-out schedule shown above may be too slow, resulting in large fees being assessed on an increasingly smaller number of conventional vehicles. In the scenario runs later in this Chapter, incentive phase-out schedules are adjusted to maintain program balance.

Since, in these measure evaluations, a majority of the projected alternative fuel vehicle purchases are by government agencies (which are not eligible to receive the incentives), the costs (and effects) of stand-alone incentive programs are limited. Results are shown in Table 10-13. These results used a common basis of assumptions about vehicle technology, cost, and consumer preference. Scenarios may be run using different sets of assumptions.

The incentive assumed for comparison of this measure with other measures was $500 per alcohol fueled vehicle and $2000 per electric vehicle, with the stated phase out rates.

Table 10-13.
Percentage Change in Cumulative Number of AFVs in 2014
Under Various Vehicle Purchase Incentive Levels

Incentive	Alcohol Vehicles	Electric Vehicles	Propane Vehicles
None	0.00%	0.00%	0.00%
$500 per alcohol vehicle	0.24%	-0.13%	-0.14%
$1000 per alcohol vehicle	0.48%	-0.25%	-0.28%
$2000 per alcohol vehicle	0.96%	-0.51%	-0.56%
$5000 per alcohol vehicle	2.41%	-1.27%	-1.40%
$500 per electric vehicle	-0.09%	0.35%	-0.07%
$1000 per electric vehicle	-0.17%	0.69%	-0.13%
$2000 per electric vehicle	-0.34%	1.40%	-0.27%
$5000 per electric vehicle	-0.88%	3.58%	-0.69%

The incentive assumed for comparison of this measure with other measures was $500 per alcohol fueled vehicle and $2,000 per EV, with the stated phase out rates.

An additional incentive could also be available for older vehicles that are scrapped, but the incentive should only be available as a credit against the purchase of a new alternative fuel vehicle. This incentive could help enlist the support of vehicle dealers for the program, and help communicate the idea that the vehicle fleet could change, as it renews, to include AFVs. The potential impact of a scrappage incentive was not evaluated.

A.20 Periodic Report on AFV Introduction

Every two years after the initiation of the vehicle incentive program, the Energy Resources Coordinator could report to the legislature on the use of the Alternative Fuel Vehicle Special Fund, the mix of technologies receiving incentives and rebates, the numbers of AFVs receiving incentives, the mix of technologies being introduced into the vehicle population, and the effectiveness of the incentives in influencing consumer choices. The Energy Resources Coordinator could adjust the fees and incentives to help Hawaii achieve its displacement and fuel mix objectives.

At the statutory level, the legislature could define the overall objectives and structure of the program. Due to uncertainties in costs and the likelihood of continuing development in technologies, the Energy Resources Coordinator could have latitude to adjust the program features as conditions change.

This measure also helps to maintain public and legislative awareness, which is projected to, in combination with other "public awareness" measures, result in a reduced length of time for the new technology acceptance process. See Measure O.2.

Personnel Requirements

Each of the above measures would require personnel at the state government level to be responsible for implementation; staffing requirements are estimated in Table 10-14.

Mandates and requirements involve both rulemaking and enforcement; these types of measures have the highest staffing requirements (next to measure A.2.C, which would require sales and bookeeping functions at each location). Incentives, although also requiring significant administrative effort, require less in the way of enforcement since only those applying for the incentives need comply with the requirements. Measures such as grants, loans, and public outreach are somewhat more flexible.

10.3.3.5 OUTREACH/EDUCATION

The following outreach and education measures could be pursued.

O.1 Continue Dialogue with Fleet Managers

It is important to continue the dialogue with fleet managers, who are natural targets of AFV programs, particularly transit operators. This dialogue is necessary to ensure that fleet operator concerns are addressed as the program evolves. This measure, in combination with other "public awareness" measures, is projected to result in a reduced length of time for acceptance of the new vehicle technologies. See Measure O.2.

Table 10-14.
Estimated Staffing Requirements for Alternative Fuel and AFV Measures

Measure #	Description of Measure	Initial	Ongoing
A.1	Alcohol or Other Oxygenate Requirement for Gasoline	1.00	0.25
A.2.A	New or Replacement Fueling Facilities to be Alcohol-Compatible	0.35	0.00
A.2.B.1	Require New Construction to Include Electrical Service Suitable for EVs	0.10	0.00
A.2.B.2	Off-Peak Recharging for Electric Vehicles Available at a Reduced Rate	0.05	0.00
A.2.B.3	Ratepayer Support for Electric Vehicle Recharging Infrastructure	0.05	0.00
A.2.C	Public Access to Government Fueling Facilities	30.00	26.00
A.3	Ethanol Blending in Diesel ("Diesohol")	3.00	0.25
A.4	Special Fund for Alternative Fuel Incentives	1.00	1.00
A.5	Increase Taxes on Gasoline and Diesel Fuel	0.20	0.10
A.6	Adjust Other Fuel Taxes on the Basis of Energy Content	0.10	0.00
A.7.A	Alcohol Producer Payments	2.00	1.00
A.8	Selective State Co-Investment	1.00	1.00
A.9	Selective State Loans	0.50	0.50
A.10	State Purchase and Distribution of Small Volumes of Alcohol	3.00	1.00
A.11	Periodic Report on Alternative Fuel Introduction	0.04	0.04
A.12	Reduce...Cost Components...Within Governmental Control	0.05	0.05
A.13.A	Establish Fleet Purchase Requirements for State Government Fleets	0.50	0.10
A.13.B	Establish Fleet Purchase Requirements for County Government Fleets	0.10	0.00
A.13.C	Establish Fleet Purchase Requirements for Private Fleets	3.00	0.50
A.13.D	Establish Purchase Requirements for Heavy Duty Vehicles	1.50	0.25
A.14	Government Vehicle Allowances	0.10	0.01
A.15	Alternative Fuel Incentives on Government Contracts	0.50	0.20
A.16	Non-discriminatory Insurance Treatment	0.01	0.01
A.17	Establish a Special Fund for AFV Incentives	1.00	1.00
A.18	Registration Fee Surcharge on Conventional Vehicles	0.20	0.10
A.19	AFV Purchase / Conversion Incentives	0.50	0.25
A.20	Periodic Report on AFV Introduction	0.04	0.04

O.2 Public Education

Public education about transportation energy use, trends in energy use, the state's energy goals, and vehicle and fuel technologies should continue to help build support for the alternative fuel program. This measure, in combination with other "public awareness" measures, is projected to result in a reduced length of time for the new technology acceptance process. This measure includes activities described under Measures A.11, A.20, O.1, O.3, O.4, and G.3. Public awareness activities are already ongoing (for example, news media coverage of alternative fuel developments, the Honolulu Clean Cities program, etc.) and are expected to continue.

The projected impact of this measure is most significant in the near-term, with 35% more AFVs by 2004 over the "future no action" case, declining to a difference of 7% in total number of AFVs in 2014. Also, since public education and awareness is strongly tied to the effectiveness of any incentive-type measure (i.e. if the public does not know about the availability of an incentive, the public will not be influenced by the incentive), the effect of this measure increases as fuel and vehicle incentives increase.

O.3 Train Alternative Fuel and AFV Technicians

This type of program helps get dealer support for the program, and would provide colleges and technical schools with a program with a good image. The training could also include alternative fuel production, storage, and distribution facilities as well as AFVs. The most efficient approach may be to "train the trainers."

O.4 Loaner AFV Program

In a "loaner" AFV program an agency purchases typical AFVs and loans them, a few days or a week at a time, to interested members of the community. This is an effective program in arousing the interest of the community in AFVs and giving them first-hand experience.

Personnel Requirements

Each of the above measures would require personnel; staffing requirements are estimated in Table 10-15. Public outreach measures are somewhat more flexible with respect to staffing requirements than mandate or incentive programs.

Table 10-15.
Estimated Staffing Requirements for Public Outreach Measures

Measure #	Description of Measure	Staffing
O.1	Continue Dialog with Fleet Managers	0.50
O.2	Public Education	1.00
O.3	Train Alternative Fuel and AFV Technicians	0.10
O.4	Loaner AFV Program	0.10

10.3.3.6 GOVERNMENTAL ACTIVITY

The following governmental actions could be pursued.

G.1 Encourage Full Funding of EPACT and EO No. 12844

The EPACT schedules for AFV introduction are not in fact occurring because EPACT and EO 12844 have not received full funding. It is in the state's energy interest to support the full funding of EPACT and EO 12844.

G.2 Address Implementation of Act 199

Since Act 199 was enacted by the Seventeenth State Legislature and signed into law by the Governor, DBEDT must draft rules to implement an ethanol mandate (see Measure A.1.a). The draft rules should allow flexibility to refiners and the market to select (and adjust, as appropriate) the optimal use of alcohol as production costs and scales change. In addition, the availability of one type of fuel flexible vehicle (FFV) (methanol, for example) may exceed the availability of another type of FFV (ethanol, for example); this will eventually affect the overall alternative fuels picture and should be taken into consideration at the time the rules are drafted.

G.3 Maintain Effective Communications with the Legislature

Since the Legislature is quite interested in energy issues, it is essential to continue to provide it with timely, correct, complete information so that the legislation that is passed is in the best interest of Hawaii's citizens.

G.4 Work to Achieve Consensus on an Omnibus Transportation Energy Bill

Building on the environmental summit process that occurred in 1993 and 1994, the state could continue to support efforts to develop comprehensive transportation energy legislation.

G.5 Ensure Hawaii Participation in the EV "Infrastructure Working Council"

The "Infrastructure Working Council" is a broadly based group that is catalyzing consensus on EV standardization issues. Hawaii utilities, EV manufacturers, or state energy experts may be appropriate representatives of Hawaii interests.

Personnel Requirements

Each of the above measures would require some degree of staffing; staffing requirements of major measures are estimated in Table 10-16. Most measures address government activities which are already ongoing; requirements would most likely be met with existing personnel.

Table 10-16.
Estimated Staffing Requirements For Governmental Activity Measures

Measure #	Description of Measure	Staffing
G.1	Encourage Full Funding of EPACT and EO No. 12844	0.00
G.2	Implement Act 199, 1994 State Legislature	same as A.1
G.3	Maintain Effective Communication with the Legislature	0.25
G.4	Work to Achieve Consensus on an Omnibus Transportation Energy Bill	0.05
G.5	Ensure Hawaii Participation in the EV "Infrastructure Working Council"	0.05

10.3.4 SUMMARY OF ALTERNATIVE FUEL MEASURES' EFFECTIVENESS

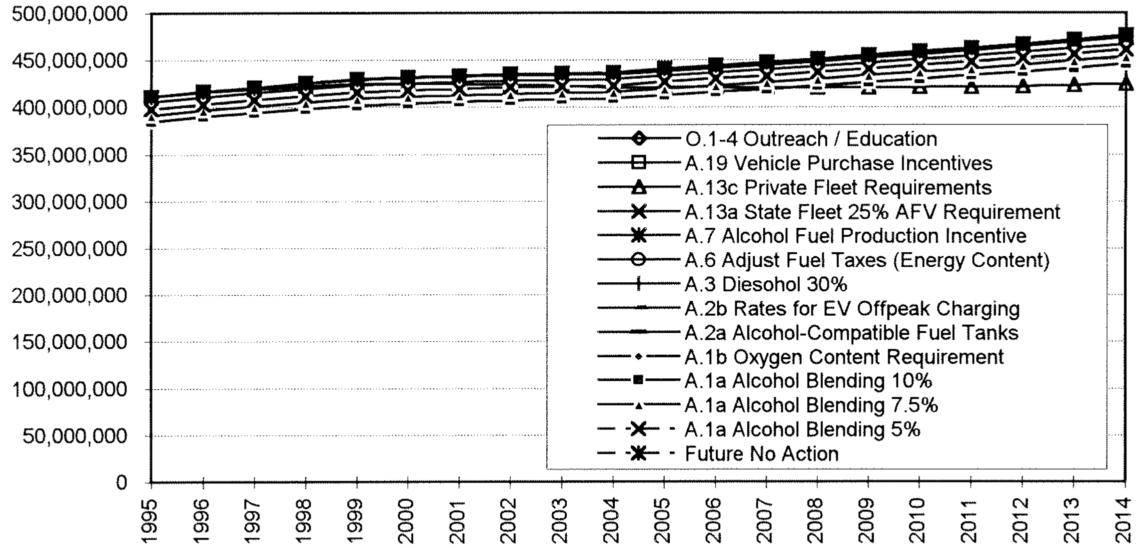
Energy, alternative fuel vehicle population, employment, and cost impacts were estimated for each of the major alternative fuel and AFV measures.

10.3.4.1 DISPLACEMENT OF GASOLINE AND DIESEL

GEG Displaced

The projected demand for gasoline and diesel fuels varies by measure, as shown in Figure 10-6 (values are more clearly presented in Table 10-18). Since the level of transportation activity and vehicle energy efficiency is held constant in for each of the measure evaluations, the reductions in demand are due to displacement of gasoline and diesel fuel by alternative fuels (i.e. the lower the demand for gasoline and diesel fuel, the higher the demand for alternative fuels). Demand is shown in terms of GEG of gasoline and diesel.

Figure 10-6.
Projected Gasoline and Diesel Demand, in GEG, 1995-2014



In all cases, projected demand for gasoline and diesel fuels in 2014 is greater than demand in 1995. Aside from measure A13c, "Private and Rental Fleets Required to Purchase AFVs," none of the measures creates more than a 10% displacement of gasoline and diesel from the "future no action" case in 2014. Even measure A13c, the measure with the greatest effect on projected gasoline and diesel demand, is not projected by itself to reduce the demand for gasoline and diesel to below 1995 levels (see Chapter 4 for a discussion of the effect of reduced rates of vehicle population increase).

Cost Per Unit of Gasoline and Diesel Displaced

Several of the measures have costs associated with their implementation. Those measures, and their associated major cost elements, are listed in Table 10-17.

Table 10-17.
Measures With Major Cost Elements

Measure		Major Cost Element
A.2.A	Alcohol or Other Oxygenate Requirement for Gasoline	State Excise Tax Exemption
A.8	Alcohol Producer Payments	Incentives Paid to Alcohol Producers
A.13.B	Fleet Purchase Requirements for State Government Fleets	AFV Purchase Price and Incremental Fuel Cost
A.13.D	Fleet Purchase Requirements for Private Fleets	AFV Purchase Price and Incremental Fuel Cost
A.20	AFV Purchase / Conversion Incentives	Incentives Paid to AFV Purchasers

Annual costs were estimated for each year between 1995 and 2014. Projected costs were distributed across the projected gasoline and diesel displacement for each year to obtain estimated cost per GEG gasoline and diesel displaced. Results are shown in Figure 10-7. **Note: potential revenue increases, added tax revenues, etc. due to increased employment or other economic activity associated with these measures was not taken into account.** The cost of program administration was also not taken into account.

Measure A13c (private fleet mandates) has the highest projected cost ($5.50 per GEG gasoline and diesel displaced in 1996). Although the fleet mandate measure requires increased AFVs purchases over the years, costs are projected to decrease due to improving technologies and reduced vehicle and fuel costs.

Measure A13a (state fleets required to purchase AFVs) shows a peak in 1998 (the first year of the requirement), with reductions in subsequent years due to improving technologies and reduced vehicle and fuel costs.

Measure A7 (payment of alcohol incentives of a level sufficient to make M85 and/or E85 competitive with gasoline at the pump) results in projected costs of approximately 50 cents to one dollar per GEG gasoline and diesel displaced over the study period. The drop in cost per GEG between the years 2000 and 2001 indicates a transition between alcohol phases. There is another (although less obvious) drop between 2011 and 2012.

The alcohol blending measures (A1a) assume that the required amounts of alcohol are used in 10% blends with gasoline, all of which would be eligible for the excise tax exemption. The cost per GEG displaced is, therefore, identical for all three blending levels. As discussed previously, an oxygenate requirement (A1b) would not involve this type of alcohol blend flexibility; therefore, measure A1b does not incur any costs relative to excise tax exemptions.

Measure A19 (vehicle purchase incentives) shows a peak in 1999 and, consistent with the incentive phase-outs used, phases out completely by 2010.

10.3.4.2 NUMBER OF ALTERNATIVE FUEL VEHICLES

As illustrated by Figure 10-8, Measure A13c is the only measure to have a significant effect on the total number of projected AFVs in use by 2014.[15]

The increased number of AFVs shown in Measure O2 (public outreach and education) illustrates an increased number of voluntary AFV purchases (as opposed to required purchases of AFVs). The other measures, by themselves, result in almost identical numbers of projected AFVs by 2014.

10.3.4.3 JOBS

Employment estimates were developed for each of the major measures; these numbers were compared using the "future no action" case as a baseline. Results are shown in Figure 10-9. Cumulative employment is indicated by columns. Projected costs were distributed across the projected cumulative number of jobs to obtain estimated cost per person-year of employment.

[15] Most of the measures slightly affect the mix of alternative fuel vehicles more than the total number of alternative fuel vehicles.

Figure 10-7.
Cost ($) per GEG of Gasoline and Diesel Displaced, 1995-2014

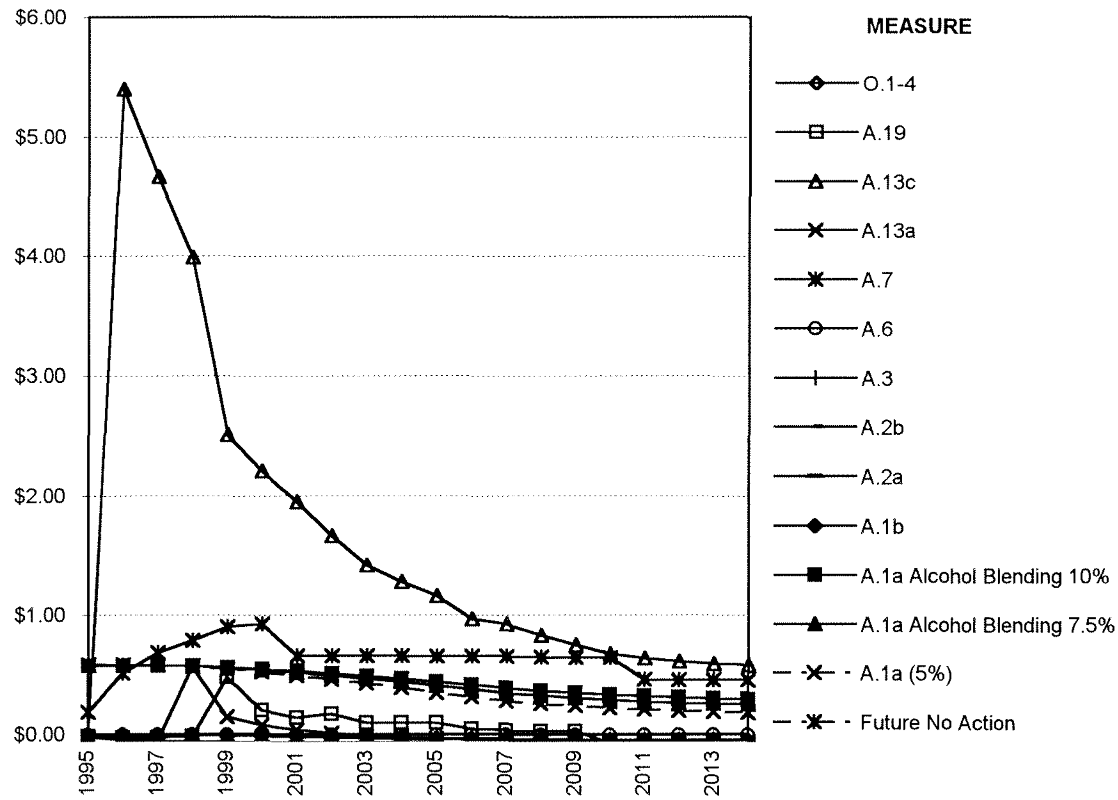


Figure 10-8.
Projected Number of Alternative Fuel Vehicles, 1995-2014

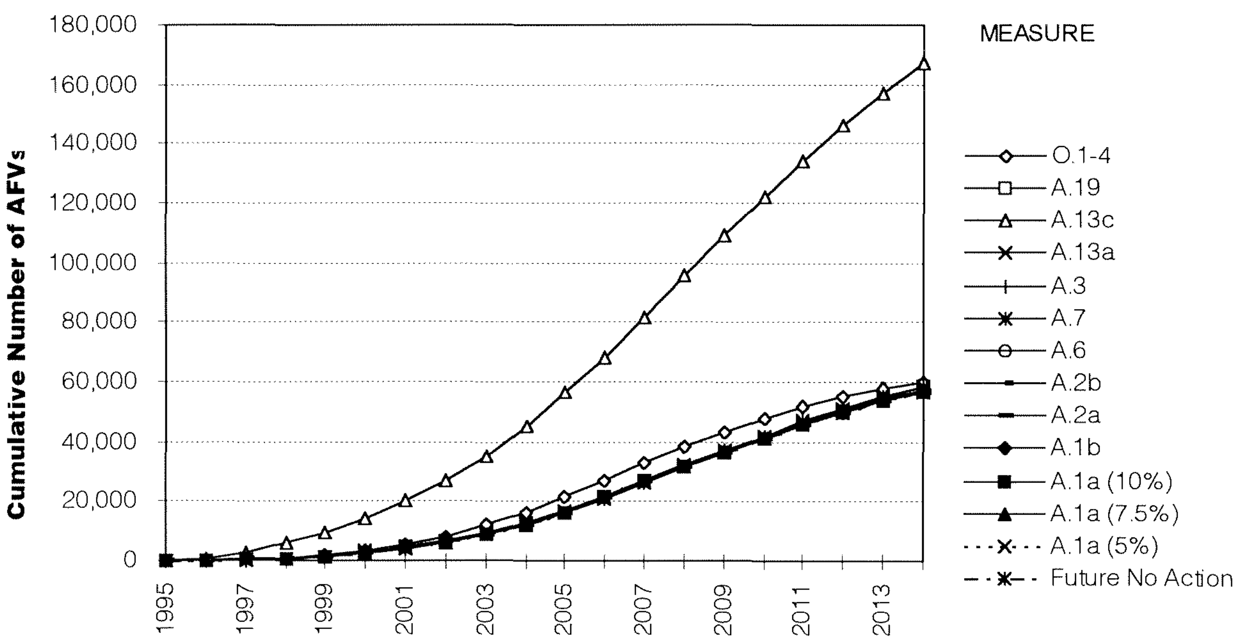
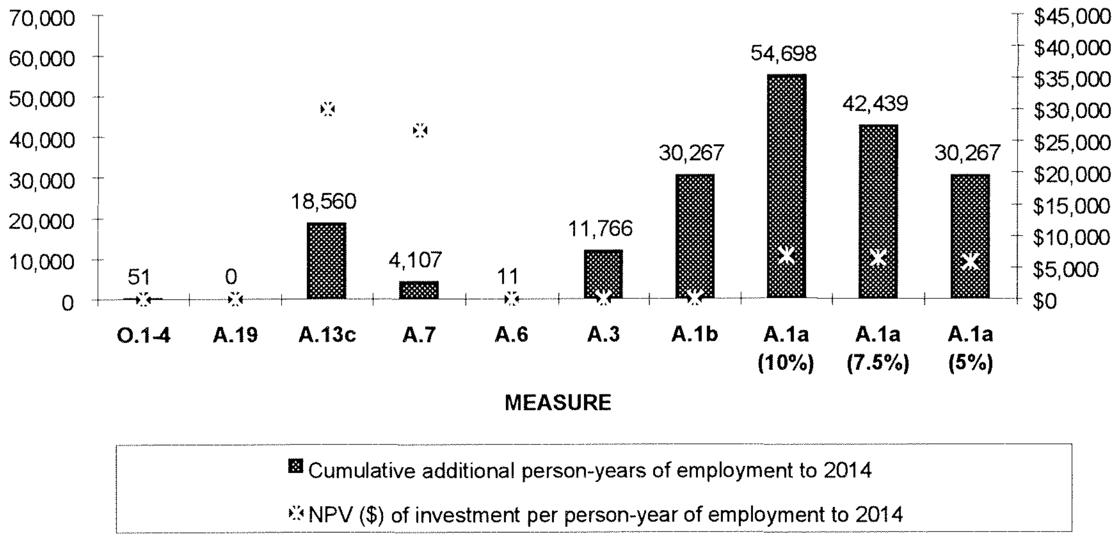


Figure 10-9.
Cumulative Employment (Person-Years, 1995-2014) And Cost Per Job



Most of the projected employment is due to local production of alcohol fuels. As described previously, the lowest cost fuel option in each phase was used for cost and employment projections. Fuel production costs were generally lowest for those options requiring the least amount of labor (and therefore providing the fewest jobs); production of alcohol fuels from agricultural crops, for example, were not projected to begin until Phase 4, when the demand for alcohol fuels exceeds 30 million GEG per year. This is apparent with measure A1a with 10% blending showing a significantly greater cumulative employment than other measures.

10.3.4.4 SUMMARY

Table 10-18 shows the projected alternative fuel demand, number of AFVs in operation, and number of jobs for most significant measures in the years 2004 and 2014. Measures are arranged in order of demand for alternative fuel in 2014.

The effectiveness of individual measures in accomplishing any one of several possible goals depends on a variety of factors. The results shown in the table above are simply one possible outcome resulting from one particular set of assumptions. As technologies, prices, and other factors change, so to will the relative effectiveness of these types of measures. The intent of this project is to provide a preliminary evaluation and to develop tools to help decision-makers evaluate the numerous options in the area of transportation energy and alternative fuels.

If the overall objectives are maximum displacement of gasoline and diesel fuel over the long term, or maximizing the number of AFVs in use, then a measure such as A13c, requiring private fleets to purchase AFVs, is projected to accomplish the greatest amount of displacement over a twenty-year timeframe (although, as previously shown, with a relatively high projected cost per GEG displaced). The next most effective single measure to maximize the number of AFVs in use is outreach / education (which is projected to increase voluntary procurement of AFVs at a minimal cost per projected GEG displaced).

Table 10-18.
Effectiveness of Individual Measures

Year	2004			2014		
Measure	Displacement of Gasoline & Diesel (Million GEG)	AFVs in Operation (Thousands)	Number of Jobs	Displacement of Gasoline & Diesel (Million GEG)	AFVs in Operation (Thousands)	Number of Jobs
A.13c Private Fleet Requirements	22	45	33	77	167	2,608
A.1a Alcohol Blending 10%	34	12	2,608	56	57	3,478
A.1a Alcohol Blending 7.5%	27	12	2,000	48	57	2,782
A.1a/A.1b Alcohol Blending 5%	20	12	1,391	41	57	2,174
A.3 Diesohol 30%	13	12	33	35	57	1,652
O.1-4 Outreach / Education	8	16	11	27	60	37
A.7 Alcohol Fuel Production Incentive	6	12	11	27	59	1,130
A.13a State Fleet 25% AFV Requirement	6	13	7	26	57	33
A.6 Adjust Fuel Taxes (Energy Content)	6	12	7	26	57	37
A.2b Rates for EV Offpeak Charging	6	12	7	26	57	33
A.2a Alcohol-Compatible Fuel Tanks	6	12	7	26	57	33
Future No Action	6	12	7	26	57	33

If the overall objective is maximum displacement of gasoline and diesel fuel over a shorter term, then the alcohol blending measures are the most effective.

If the objective is to maximize employment in an alternative fuels industry, then the measures which maximize use of alcohol fuels are the most effective.

If the objective is a cost-effective program which accomplishes several goals simultaneously, then a mix of measures may be appropriate. Groups of measures are evaluated in the next section.

10.4 COMBINATIONS OF MEASURES (POSSIBLE SCENARIOS)

Several of the measures described in the previous section are complementary to each other. For example, a measure such as alcohol blending may spur local fuel production of several million gallons per year and thus allow the lower-volume, higher-cost phases of alcohol (M85/E85) for use in AFVs to be avoided. Or, the provision of vehicle incentives may increase the attractiveness of AFVs (and therefore the demand for fuel), thereby reducing fuel costs.

Some measures may interfere with one another or increase program costs. For example, aggressive AFV measures (such as private fleet mandates) increase the number of alternative fuel vehicles and reduce the number of conventionally fueled vehicles - which reduces the amount of conventional fuel into which low levels of alcohol may be blended. Another example would be a case in which alcohol incentives were put into place with the intent of making high-level alcohol fuels cost competitive with gasoline, but those incentives were used for low-level blends (for which a much smaller incentive, if any, would have been sufficient); in such a case, large costs would have been incurred with little additional benefit.

The following section evaluates groups of measures ("scenarios") for overall effectiveness and cost.

10.4.1 MEASURES ASSOCIATED WITH ALL SCENARIOS

Several measures have been included as common elements in all scenario runs. In general, these are measures which have already occurred to some extent, are occurring or expected to occur voluntarily, or are essentially non-controversial and non-cost items. The measures included as common elements in all scenario runs are shown in Table 10-19.

Table 10-19.
Measures Included as Common Elements in All Scenario Runs

A.2.a	New or Replacement Fueling Facilities to be Alcohol-Compatible
A.2.b.2	Off-Peak Recharging for Electric Vehicles Available at a Reduced Rate
A.6	Adjust Fuel Taxes on the Basis of Energy Content
A.13.a	Fleet Purchase Requirements for State Government Fleets
O.2	Public Education / Outreach

Measure A.2.a is expected to occur voluntarily to some extent; as discussed previously, increasingly stringent underground tank requirements may result in voluntary installation of highly corrosion-proof tanks, such as double-walled stainless steel tanks, which are compatible with high level alcohol blends. Measure A.2.b.2, off-peak recharging of electric vehicles, is highly desirable from an electric utility load management point of view, and without some type of incentive and control over EV recharging times, utilities could experience increased loads at their peak load times; therefore, this measure is considered likely. Measure A.6, adjustment of fuel taxes on the basis of energy content, would remove a disincentive to alternative fuel use while maintaining funding levels for highways; therefore, this measure is considered a non-controversial, non-cost item. Measure A.13.a, State Government Fleet Purchase Requirement, has already occurred with Administrative Directive 94-06. Measure O.2 is already occurring, with public and private organizations cooperating in public education and outreach on the topic of alternative fuels and AFVs.

10.4.2 SCENARIOS

Measures were combined in nine scenarios to illustrate a range of approaches. The nine measure combinations (scenarios A through I) are described below.

A. Common Elements Only
B. Ethanol Blending (10%)
C. Ethanol Blending (10%) & Alcohol Vehicle Purchase Incentives
D. Alcohol (M85/E85) Fuel & Vehicle Purchase Incentives
E. Alcohol (M85/E85) Fuel & Vehicle Purchase Incentives & Alcohol (10%) Blending
F. Alcohol & Electric Vehicle Purchase Incentives
G. Ethanol Blending (10%) & Vehicle Incentives; Fleet Mandates Later
H. Fleet Mandates & Fuel & Vehicle Incentives
I. Everything

SCENARIO A: COMMON ELEMENTS ONLY

In this scenario, common elements only (see previous section) were included. This scenario resulted in a decrease of gasoline and diesel demand in 2014 of 0.5% compared to the "future no action" case. This scenario also resulted in an increase in total number of AFVs of 40% in 2004 and 8% in 2014 over the "future no action" case.

SCENARIO B: ETHANOL BLENDING (10%)

In this scenario, 10% ethanol blending and common elements were included. This scenario resulted in an increase in the displacement of gasoline and diesel fuel by alcohol in 2014 of 300% compared to the "future no action" case. This scenario also resulted in an increase in total number of AFVs of 41% in 2004 and 10% in 2014 over the "future no action" case.

SCENARIO C: ETHANOL BLENDING (10%) & ALCOHOL VEHICLE INCENTIVES

In this scenario, ethanol blending, alcohol vehicle incentives of $500 per vehicle (using the same phase-outs as in the individual measure evaluations of the previous section), and common elements were included. This scenario resulted in an increase in the displacement of gasoline and diesel fuel by alcohol in 2014 of 300% compared to the "future no action" case. This scenario also resulted in an increase in total number of AFVs of 41% in 2004 and 10% in 2014 over the "future no action" case.

SCENARIO D: ALCOHOL (M85/E85) FUEL & VEHICLE INCENTIVES

In this scenario, alcohol fuel incentives (payment of alcohol incentives of a level sufficient to make M85 and/or E85 competitive with gasoline at the pump), alcohol vehicle purchase incentives of $500 per vehicle (using the same phase-outs as in the individual measure evaluations of the previous section), and common elements were included. This scenario resulted in an increase in the displacement of gasoline and diesel fuel by alcohol in 2014 of 34% compared to the "future no action" case. This scenario also resulted in an increase in total number of AFVs of 43% in 2004 and 12% in 2014 over the "future no action" case.

SCENARIO E: ALCOHOL (M85/E85) FUEL & VEHICLE INCENTIVES & ETHANOL BLENDING (10%)

In this scenario, alcohol fuel incentives (payment of alcohol incentives of a level sufficient to make M85 and/or E85 competitive with gasoline at the pump), alcohol vehicle purchase incentives of $500 per vehicle (using the same phase-outs as in the individual measure evaluations of the previous section), ethanol blending, and common elements were included. This scenario resulted in an increase in the displacement of gasoline and diesel fuel by alcohol in 2014 of 320% compared to the "future no action" case. This scenario also resulted in an increase in total number of AFVs of 43% in 2004 and 12% in 2014 over the "future no action" case.

SCENARIO F: VEHICLE PURCHASE INCENTIVES

In this scenario, vehicle purchase incentives of $500 and $2000 per alcohol and electric vehicle, respectively (using the same phase-outs as in the individual measure evaluations of the previous section) and common elements were included. This scenario resulted in an increase in the displacement of gasoline and diesel fuel in 2014 of 0.5% compared to the "future no action" case. This scenario also resulted in an increase in total number of AFVs of 40% in 2004 and 9% in 2014 over the "future no action" case.

SCENARIO G: ETHANOL BLENDING (10%) & VEHICLE INCENTIVES; FLEET MANDATES LATER

In this scenario, 10% ethanol blending, vehicle purchase incentives of $500 and $2000 per alcohol and electric vehicle, respectively (using delayed phase-outs), delayed fleet mandates, and common elements were included. Fleet mandate and incentive phase-out rates used are shown in Table 10-20.

Table 10-20.
Fleet Mandate and Incentive Phase-Out Rates Used for Scenario G

Year	Rental fleets	Private (non-rental) fleets	EPACT
	percentage of new vehicles required to be AFVs:	percentage of new vehicles required to be AFVs:	requirement for non-government "covered fleets"
1995	0%	0%	0%
1999	0%	10%	20%
2003	10%	25%	40%
2007	20%	50%	70%
2009	25%	50%	70%
2011	30%	50%	70%
2015	40%	50%	70%

Phase	Period				% of original incentive
Phase 1	from	1995	to	2002	100%
Phase 2	from	2002	to	2005	75%
Phase 3	from	2005	to	2007	50%
Phase 4	from	2007	to	2009	35%
Phase 5	from	2009	on...		0%

This scenario resulted in a decrease of gasoline and diesel demand in 2014 of 14% compared to the "future no action" case. This scenario also resulted in an increase in total number of AFVs of 170% in 2004 and 140% in 2014 over the "future no action" case.

SCENARIO H: FLEET MANDATES WITH FUEL INCENTIVES & VEHICLE PURCHASE INCENTIVES

In this scenario, fleet mandates (using the same percentage requirements as in the individual measure evaluations of the previous section), alcohol fuel incentives (payment of alcohol incentives of a level sufficient to make M85 and/or E85 competitive with gasoline at the pump), vehicle purchase incentives of $500 and $2000 per alcohol and electric vehicle, respectively (using the accelerated phase-outs shown in Table 10-21), and common elements were included. The accelerated rate of incentive phase out is due to the large number of vehicles being purchased by fleets due to mandate requirements.

Table 10-21.
Incentive Phase-Out Rates Used for Scenarios H and I

Phase	Period				% of original tax credit
Phase 1	from	1995	to	1997	100%
Phase 2	from	1997	to	1999	75%
Phase 3	from	1999	to	2001	50%
Phase 4	from	2001	to	2003	35%
Phase 5	from	2003	on...		0%

This scenario resulted in a projected decrease of gasoline and diesel demand in 2014 of 11% compared to the "future no action" case. This scenario also resulted in an increase in total number of AFVs of 290% over the "future no action" case in 2004 and of 200% in 2014.

SCENARIO I: EVERYTHING

In this scenario, fleet mandates (using the same percentage requirements as in the individual measure evaluations of the previous section), alcohol fuel incentives (payment of alcohol incentives of a level sufficient to make M85 and/or E85 competitive with gasoline at the pump), vehicle purchase incentives of $500 and $2000 per alcohol and electric vehicle, respectively (using the same accelerated phase-outs as used in Scenario H), ethanol blending (10%), diesohol (30%), and common elements were included. This scenario resulted in a decrease of gasoline and diesel demand in 2014 of 19% compared to the "future no action" case. This scenario also resulted in an increase in total number of AFVs of 290% in 2004 and 200% in 2014 over the "future no action" case.

10.4.3 SUMMARY OF SCENARIOS' EFFECTIVENESS

Energy, alternative fuel vehicle population, employment, and cost impacts were estimated for each of the scenarios described in the previous section.

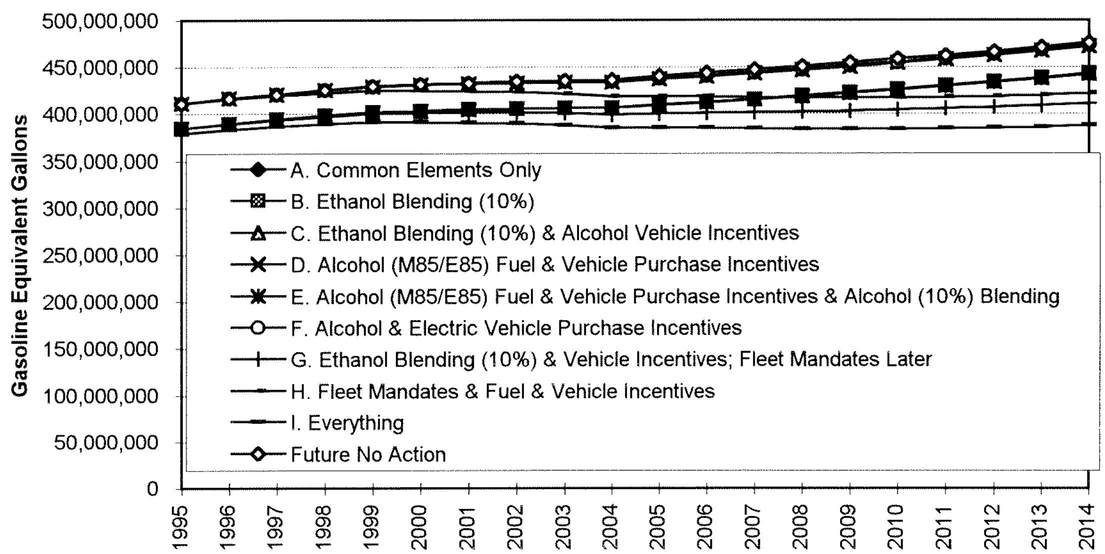
10.4.3.1 DISPLACEMENT OF GASOLINE AND DIESEL

GEG Displaced

The projected demand for gasoline and diesel fuels varies by scenario, as shown in Figure 10-10. Demand is shown in terms of GEG of gasoline and diesel.

As may be expected, the projected displacement of gasoline and diesel in 2014 is greatest for those scenarios involving fleet mandates and alcohol blending (Scenarios G and I), followed by fleet mandates without alcohol blending (Scenario H). Very similar projections of gasoline and diesel demand are obtained for Scenarios B, C, and E, indicating that the most significant element in those scenarios is the shared element of ethanol blending; likewise, similar projections are obtained for Scenarios A, D, and F, indicating that the proposed level and application of fuel and vehicle credits, even in combination, are not projected to have a significant effect on overall demand for gasoline and diesel.

Figure 10-10.
Projected Gasoline and Diesel Demand Under Various Scenarios, 1995-2014



In all cases, projected demand for gasoline and diesel fuels in 2014 is equal to or greater than demand in 1995.

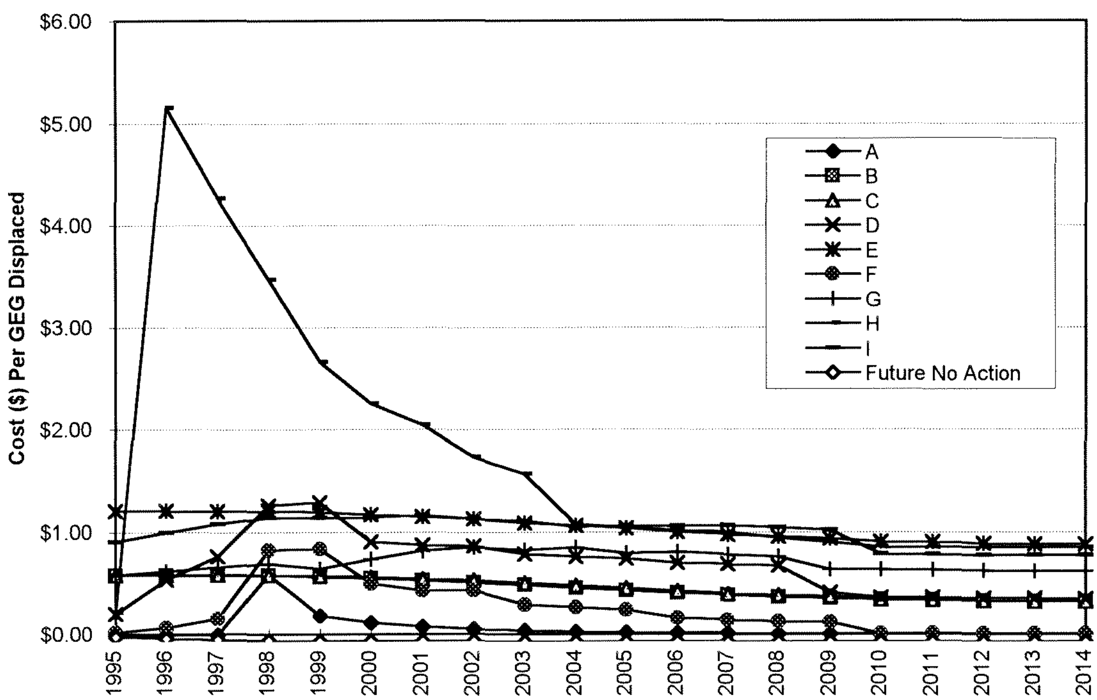
Cost Per Unit of Gasoline and Diesel Displaced

Several of the measures included in scenario runs have costs associated with their implementation. Costs for scenarios were determined for each year between 1995 and 2014. Projected costs were distributed across the projected gasoline and diesel displacement for each year to obtain estimated cost per GEG gasoline and diesel displaced. Results are shown in Figure 10-11. **Note: potential revenue increases, added tax revenues, etc. due to increased employment or other economic activity associated with these scenarios were not taken into account.** Program administration costs were not included either. These costs and benefits may be quantified and added as program direction and scope are refined.

Scenario H (fleet mandates with fuel and vehicle incentives) has the highest projected cost (over $5.00 per GEG gasoline and diesel displaced in 1996). This projected cost is lower than was projected in the previous section for fleet mandates alone because the combination of mandates and incentives increases demand for the fuels enough to slightly reduce fuel costs.

Scenarios I (everything) and **E** (alcohol fuel & vehicle incentives & ethanol blending) have costs which are lower than Scenario H, due to the combination of measures resulting in high enough demand to cause additional reductions in fuel costs. The level of displacement for Scenario I is more than twice the level of displacement of Scenario E, with similar costs ($0.82 and $0.81 in 2014, respectively).

Figure 10-11.
Cost ($) per GEG of Gasoline and Diesel Displaced Under Various Scenarios, 1995-2014



The level of displacement for **Scenario E** is similar to displacement for **Scenario C** (ethanol blending & alcohol vehicle incentives), but the cost per GEG displaced in Scenario C ($0.32 in 2014) is less than half of cost per GEG displaced in Scenario E. The difference between the two scenarios is that Scenario E includes paying alcohol fuel production incentives of a level sufficient to make M85 and/or E85 competitive with gasoline at the pump (while simultaneously using large quantities of alcohol fuels in low-level blends); Scenario C includes the ethanol blending and vehicle incentives but not the production incentives for the high level blends.

Scenario D (alcohol fuel & vehicle incentives) has a cost ($0.35 per GEG) greater than **Scenario C**, with one-tenth the level of displacement. **Scenario B** had costs ($0.32 per

GEG in 2014) and displacements almost identical to Scenario C. Scenarios B and C had the fifth highest level of displacement and third lowest cost per GEG displaced.

This wide variation in costs and results in scenarios targeting alcohol fuels illustrates the importance of providing cost-effective incentives which are necessary (don't pay more than is necessary) and sufficient (don't pay less than is sufficient). If low-level blends are in use, paying producer incentives geared towards high level blends is more than is necessary. If low-level blends are not in use, vehicle and fuel incentives alone are not sufficient to accomplish a significant level of displacement.

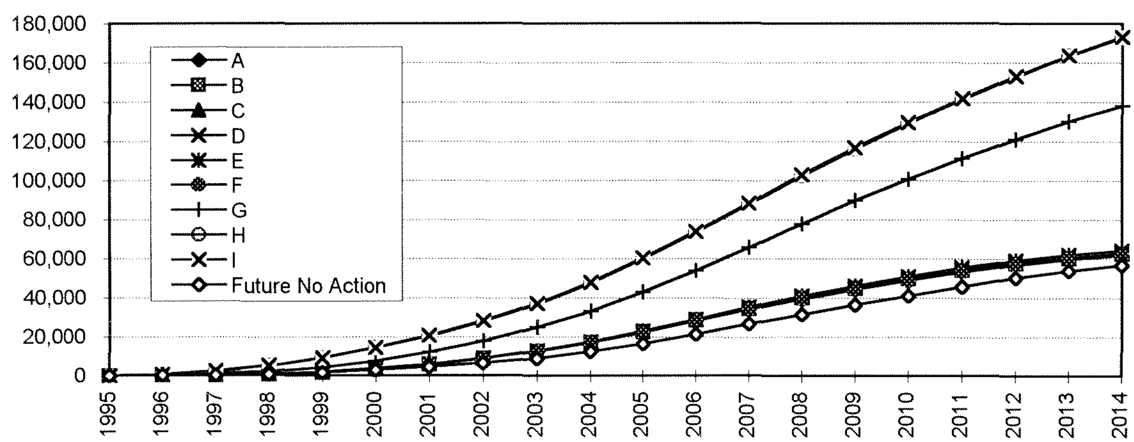
Scenario G (ethanol blending & vehicle incentives; fleet mandates later) starts with ethanol blending and phases in fleet mandates later, when fuel and vehicle costs have been reduced. This scenario has the second highest level of displacement and sixth lowest cost per GEG displaced. Costs of this scenario could be reduced if vehicle incentives were reduced or phased out at a faster rate.

Scenario F, vehicle incentives only, resulted in even less displacement than Scenario D, but at no cost in 2014 since the incentives are phased out. This approach, although without the levels of displacement of the other scenarios, is relatively low-cost and low-risk. **Scenario A**, common elements only, resulted in the lowest levels of displacement, with the lowest costs. This approach, although without the levels of displacement of the other scenarios, is the lowest-cost and lowest-risk.

10.4.3.2 NUMBER OF ALTERNATIVE FUEL VEHICLES

As illustrated by Figure 10-12, the scenarios with fleet mandates (Scenarios G, H and I) are projected to have significantly more AFVs in use by 2014.

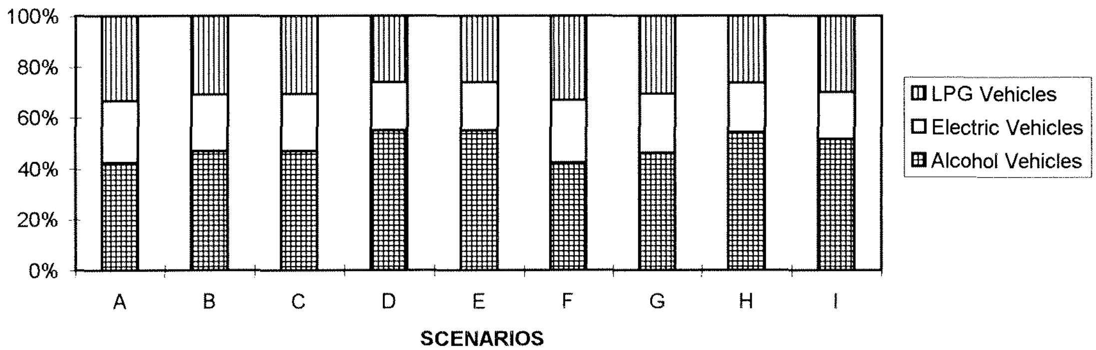
Figure 10-12.
Projected Number of Alternative Fuel Vehicles Under Various Scenarios, 1995-2014



Even without fleet mandates, several thousand (about 60,000) AFVs are projected to be in use by 2014. The difference in total number of vehicles between the various scenarios and the "future no action" case is due to increased voluntary purchases of alternative fuel vehicles (primarily due to public outreach efforts).

The total number of AFVs projected under scenarios A through F remain fairly constant, in spite of different combinations of fuel and vehicle incentives. The overall effect of the modeled incentives was to influence the mix of alternative fuel vehicles, as illustrated by Figure 10-13, rather than to increase the total number of alternative fuel vehicles. These results are very sensitive to availability of alternative fuel vehicles from the manufacturers.

Figure 10-13.
Estimated Mix of Alternative Fuel Vehicles Under Various Scenarios, 2014



10.4.3.3 JOBS

The employment potential of each of the various scenarios was estimated; as in the measure evaluations, the majority of the projected jobs occur when the demand for alcohol fuels becomes greater than 30 million gasoline equivalent gallons per year. Results are shown in Figure 10-14.

The discontinuities ("steps") in number of jobs occur at alcohol production phase transitions. For example, Scenario I (the "do everything" case) shows two discontinuities: a large increase in employment in 1997, which corresponds to a transition from alcohol production phase 3 to phase 4, and a large decrease in employment in 2012, which corresponds to a transition from alcohol production phase 4 to phase 5 (cost estimates for phase 5 have methanol produced from coal as the lowest-cost alcohol fuel option under stated assumptions).

Projected cost per unit of employment for each of the scenarios was obtained by dividing projected cumulative costs in constant dollars (cost elements are discussed in the previous section) by potential cumulative person-years of employment between 1995 and 2014. Results are shown in Figure 10-15.

As illustrated by the columns representing employment, potential employment under an alternative transportation fuels program varies considerably from one scenario to another. Cost per job also varies considerably; the lowest cost per job occurs with Scenario A, but the total number of jobs is very small as well. Scenarios B and C show potential for over 50,000 cumulative person-years of employment between 1995 and 2014, at a projected cost of less than $7,000 each, based on existing taxes, technologies, and mid-range of costs.

Figure 10-14.
Potential Employment Under Various Scenarios, 1995-2014

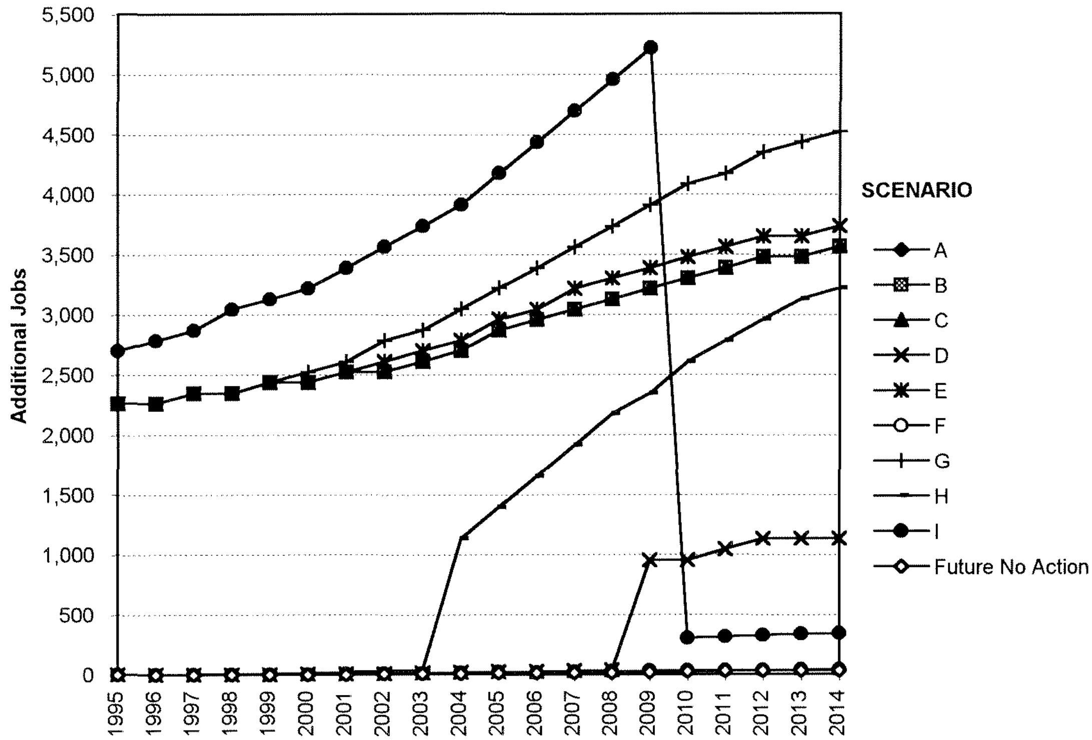
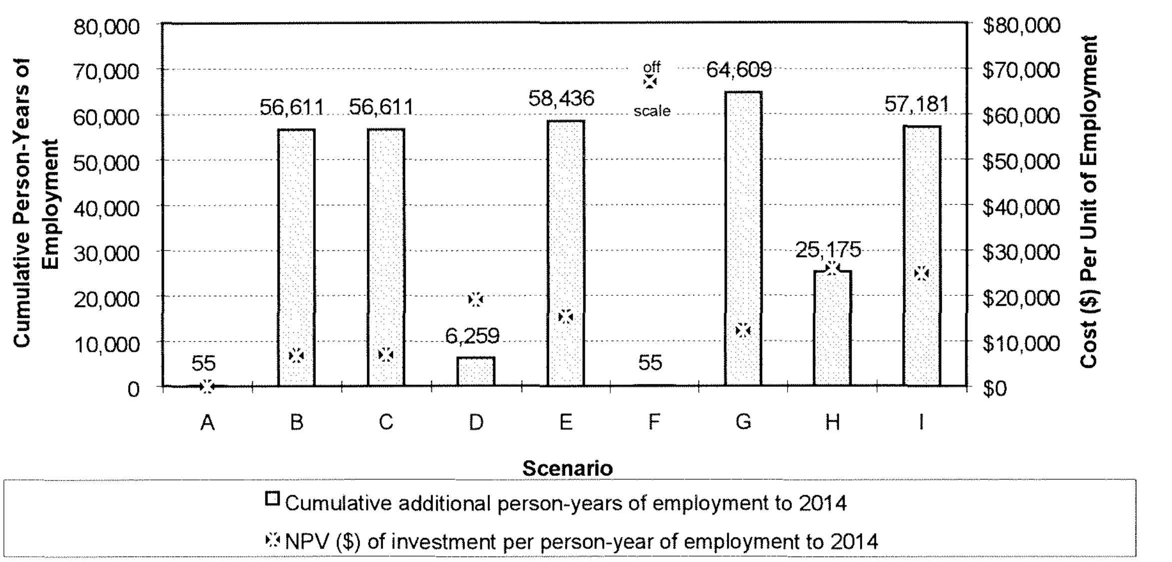


Figure 10-15.
Cumulative Employment (Person-Years, 1995-2014) and Cost Per Job



10.4.3.4 SUMMARY

Table 10-22 shows the projected alternative fuel demand, number of AFVs in operation, and number of jobs for each scenario in the years 2004 and 2014. Scenarios are arranged in order of identification letter (A-I).

If the overall objectives are maximum displacement of gasoline and diesel fuel, or maximizing the number of AFVs in use, then scenarios G and I are projected to accomplish the greatest amount of displacement both immediately and over a twenty-year timeframe (although, as previously shown, with a relatively high projected cost per GEG displaced).

If the objective is the lowest cost per GEG of gasoline and diesel displaced, than scenario A is preferable, although the magnitude of displacement is less than other scenarios. If the objective is maximum potential employment, cumulative over a twenty year timeframe, then Scenario I is preferred. If the objective is significant employment potential at the lowest cost, then Scenario B is preferred.

If a combination of objectives are to be met, then Scenario G, which provides the second highest level of gasoline and diesel fuel displacement and second highest level of employment with the fourth highest cost per GEG displaced and sixth highest cost per person-year of employment, may be the preferred option.

The scenarios evaluated are merely a sample of possible approaches. As costs, technologies, and resource constraints change, the tools developed for this project may be updated and used to evaluate the new situation.

Table 10-22.
Effectiveness of Various Scenarios

Year / Measure	2004			2014		
	Displacement of Gasoline & Diesel (Million GEG)	AFVs in Operation (Thousands)	Number of Jobs (in 2004)	Displacement of Gasoline & Diesel (Million GEG)	AFVs in Operation (Thousands)	Number of Jobs (in 2014)
A. Common Elements Only	2	17	11	2	62	37
B. Ethanol Blending (10%)	30	17	2,695	32	63	3,565
C. Ethanol Blending (10%) & Alcohol Vehicle Purchase Incentives	30	17	2,695	32	63	3,565
D. Alcohol (M85/E85) Fuel & Vehicle Purchase Incentives	3	17	18	4	64	1,130
E. Alcohol (M85/E85) Fuel & Vehicle Purchase Incentives & Alcohol (10%) Blending	30	17	2,782	33	64	3,738
F. Alcohol & Electric Vehicle Purchase Incentives	2	17	11	2	62	37
G. Ethanol Blending (10%) & Vehicle Incentives; Fleet Mandates Later	37	33	3,043	65	138	4,521
H. Fleet Mandates & Fuel & Vehicle Incentives	18	47	1,130	54	173	3,217
I. Everything	51	48	3,912	88	173	339
Future No Action	0	12	7	0	57	33